

**"A Single Courageous State":
A Study of the Diffusion of Science and Technology
Policy Innovations Among States**

by

John J. Cole

**A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Education)
in the University of Michigan
2011**

Doctoral Committee:

Professor Stephen L. DesJardins, Co-Chair
Professor Emeritus Marvin W. Peterson, Co-Chair
Professor James J. Duderstadt
Associate Professor Michael N. Bastedo

Dedication

With great love and respect, I dedicate this to my parents, Burhl and Billie Cole, who made everything possible with their unconditional love, support, and encouragement.

Also with great love and respect, I dedicate this to my wife and best friend, Dr. Lisa DeFrank-Cole, who sets a personal and professional example

I can only aspire to follow.

Table of Contents

Dedication	ii
List of Figures	iv
Chapter One: Purpose and Significance of the Study	1
Historical background	2
Problem and purpose of the study	11
Significance of the study	13
Chapter Two: Literature Review	22
General review on innovation and diffusion	23
Policy innovation and diffusion	24
Education policy innovation and diffusion	41
Higher education policy innovation and diffusion	44
Summary and synthesis of literature review	53
Chapter Three: Research Design and Framework	59
Conceptual framework	60
Hypotheses	61
Explanation of conceptual framework	70
Chapter Four: Research Methods	86
Definition of variables	87
Research strategy	89
Study population	96
Data sources	97
Chapter Five: Results and Analysis	101
Independent variables	101
Hazard	107
EHA results and analysis, by dependent variable	109
Connection to other studies	127
Chapter Six: Conclusions and Implications	129
Summary	130
Limitations	132
Additional covariates of interest	134
Additional dependent variables	136
Need for mixed-method approach	139
Further exploration of "academic cartel" theory	142
After innovation	145
Conclusion	147
References	149

List of Figures

Figure 1. Independent Variables in Policy Diffusion Studies, 1969-2008	54
Figure 2. Synthesis of Independent Variables from Literature Review	56
Figure 3. Conceptual Framework	60
Figure 4. Definition of Dependent Variables	87
Figure 5. Definition of Independent Variables	88
Figure 6. Descriptive Statistics for Independent Variables	101
Figure 7. Hazards for Science and Technology Strategic Plans	110
Figure 8. EHA Results for Science and Technology Strategic Plans	110
Figure 9. Hazards for Science and Technology Councils	114
Figure 10. EHA Results for Science and Technology Councils	114
Figure 11. Hazards for Cooperative Technology Programs	122
Figure 12. EHA Results for Cooperative Technology Programs	123
Figure 13. Summary of Findings	131

Chapter One
Purpose and Significance
of the Study

"It is one of the happy incidents of the federal system that a single courageous State may, if its citizens choose, serve as a laboratory, and try novel social and economic experiments without risk to the rest of the country." -Justice Louis Brandeis

The role of states in science and technology remains ambiguous, despite numerous efforts to bring clarity to the issue. One significant aspect of the states' role is the decision by states to adopt, or not adopt, science and technology policy innovations. These decisions are political decisions, made by Governors and/or State Legislatures, and they have the potential to benefit states' efforts to build research capacity and stimulate high-tech economic development. No state wants to be left behind in the rush to adopt policy innovations that will increase competitiveness for new funding, new jobs, and new knowledge creation.

The purpose of this dissertation is to examine the effects of demographic, economic, and political factors on states' innovation adoption (or non-adoption) behaviors. By exploring the effects of different, well-established variables on the diffusion of state science and technology policy innovations, this dissertation will make an original contribution to the limited literature on state science and technology policy, as well as the more extensive literature on innovation and policy diffusion.

The following chapter is divided into three sections. The first section provides a brief historical background on the role of states, institutions, and the federal government in the formulation and implementation of science and technology policy. The second section describes the problem and the purpose of this study. The third and final section outlines the significance of this study.

Historical Background

At the institutional level, German universities were the primary inspiration for the rise of a research culture in American higher education in the 1800s. "The impact of German university scholarship upon nineteenth-century American higher education is one of the most significant themes in modern intellectual history...The essence of the

German university system, which gave it intellectual leadership in the nineteenth century, was the concept that an institution of true higher education should be, above all, the workshop for free scientific research" (Brubacher and Rudy, 1976, p. 174).

With the creation of research-focused institutions such as Johns Hopkins in 1876 and the expansion of research and graduate education at existing institutions such as Harvard, Columbia, Michigan, and Wisconsin throughout the late 1800s, research (and science as the primary field of research) became central to the mission of American higher education. "The professionalization of the research function developed rapidly, with contributions to the advancement of knowledge becoming an expectation for the higher prestige levels of academic faculties" (Parsons and Platt, 1973, p.5). The culmination of the rise of research came in 1900 with the establishment of the Association of American Universities (AAU), a consortium of institutions with the strongest orientation toward research and graduate education. "The AAU encompassed presidents and deans who wished to discuss policy-making specifically in the area of higher degrees; its title thus suggested that research was the intrinsic function of 'the' university in the United States" (Veysey, 1965, p. 175).

While institutions developed a research culture, government began to establish science and technology research policy to facilitate and subsequently harness the power of these cultures. The role of state governments in science and technology policy, however, was limited until the mid-20th century. From the nation's founding through World War II, the federal government sketched the agenda for such a policy, beginning in the broadest sense with the Northwest Ordinance of 1787, which made the initial case for the importance of education and, by extension, research in science. The primary purpose of this legislation, approved by the Continental Congress and later affirmed by the United States Congress as established by the Constitution of 1789, was to set forth the procedure by which new states would be admitted to the Union.

However, the ordinance did touch briefly on education in Article III: "Religion, morality, and knowledge, being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged" (Northwest Ordinance Act of July 13, 1787). Because the land that was to become the state of Michigan was a significant part of the so-called Northwest Territories, these words were also chiseled onto the edifice of Angell Hall at the University of Michigan as a

reflection of the relationship between the ordinance and the growth of public higher education.

Other early examples of federal involvement in science and research policy were the 1862 and 1890 Morrill Acts, which provided "land grants" to states to help them pay for the establishment of colleges and universities, and the 1887 Hatch Act, which extended the 1862 Morrill Act by establishing agricultural research and experiment stations at these land grant universities. The Morrill Acts, named for their champion Vermont Congressman Justin Morrill, also gave state legislatures a role. According to the law, "...the leading object [of these institutions] shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and mechanic arts, *in such manner as the legislatures of the States may respectively prescribe*, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life" (First Morrill Act, July 2, 1862, Public Law 37-108).

By the conclusion of World War II, the federal government took a direct interest in science policy. "A distinctive feature of American government since World War II has been the emergence of 'science policy' as a focus of

thought and action" (Smith, 1990, p.1) As Director of the U.S. Office of Scientific Research and Development under President Franklin Roosevelt, Vannevar Bush focused on federal science and research policy and crafted the "social contract that led to a partnership between the federal government and the American university which aimed at the support and conduct of basic research" (Duderstadt and Womack, 2003, pp. 52-53). However, Bush's post-World War II landmark report, *Science: The Endless Frontier*, also had substantial implications for state-level science policy and research funding, and provided the first overview of the impact of research policies on issues of direct importance to states, such as public health and economic prosperity (Bush, 1945).

The political and educational crisis prompted by the success of Sputnik in 1957 and the subsequent passage of the 1958 National Defense Education Act placed states, with their constitutional authority for education, and their educational institutions on the front lines in terms of educating the next generation of scientists and engineers (Clowse, 1981). During the 1960s, state science and technology policy became one part of a larger discussion about the rise of the "multiversity" and its place in society (Kerr, 1963).

All three U.S. Presidents who served during the 1970s attempted to clarify the state role in science and technology and the setting of research policy: Presidents Nixon and Carter through special messages to Congress on science and technology issues and President Ford through the National Science and Technology Policy Organization and Priorities Act.

At the state level, the Council of State Governments and the National Governors Association (NGA) were both active in the 1970s and early 1980s advocating for an expanded state role in science and research policy through reports, such as *Power to the States* (Council of State Governments, 1972), and new organizational structures, such as the Intergovernmental Science, Engineering, and Technology Advisory Panel.

More recently, the Carnegie Commission on Science, Technology, and Government issued a report, *Science, Technology, and the States in America's Third Century*, which sought to strengthen policy and budgetary linkages between the federal and state levels on science and technology activities (Carnegie Commission, 1992). In the mid-1990s, the Battelle Memorial Institute produced an inventory of federal-state cooperative technology programs, with a discussion of related research policy implications

(Coburn and Berglund, eds., 1995). Emerging from the earlier work of the NGA was a joint project between NGA and the White House Office of Science and Technology Policy, the State-Federal Technology Partnership Task Force, which issued its own report on state research, science, and technology policies in 1995 (SFT Partnership Task Force, 1995).

The shifting of the federal science and technology agenda to the state level has continued in recent years, most dramatically with the 2005 National Academies report, *Rising Above the Gathering Storm*, and the subsequent passage and signing of the America COMPETES (Creating Opportunities to Meaningfully Promote Excellence in Technology, Engineering, and Science) Act in 2007. This legislation authorized significant new federal investment in education and research. To prepare for these proposed funding increases, states have been working to ensure they have policies and procedures that will enable them to make the best use of these funds.

This trend has accelerated sharply with the passage in 2009 of the American Recovery and Reinvestment Act (ARRA), which is pushing billions of dollars from the federal to the state level and gives governors and legislators the authority to allocate these funds on a range of projects,

from construction of new scientific facilities to the training of new teachers. The decisions states make in these areas will have significant consequences on their ability to compete in the 21st century.

Concurrent with this shift from the federal to the state level—and the infusion of new money—numerous advocacy and/or informational organizations have developed around the issue of state research and science and technology policy. These organizations include the Alliance for State Technology and Research Administration, the State Science and Technology Institute, the Science and Technology Council of the States, and, as an example at the regional level, the Southern Growth Policies Board. States are evaluated and ranked on various indicators of their research and science policies by organizations such as the Milken Institute (2005) and the Progressive Policy Institute (2002). Top rankings in these reports and surveys are coveted by states because they generate positive “buzz” in the media and the business community about which states are leading the high-tech economic development race.

Some national organizations, such as the American Association for the Advancement of Science, have developed specific offices and/or agendas to address state research

concerns. The National Science Foundation (NSF) collects, analyzes, and reports on state research, science, and technology data and policies (NSF Division of Science Resources Studies, 1999, 2001, 2003). Recognizing the impact of economic and technological shifts on research, university leaders have advocated for a new "social contract" that links "federal and state investment with higher education and business to serve national and regional needs, much in the spirit of the land grant acts of the nineteenth century" (Duderstadt, 2000, p. 129). A small number of scholars have also attempted to describe the roles of states in research and science policy (Feller, 1992 and 1997; Geiger, 1993), and to subject these roles to further empirical study (Jones, Guston, and Branscomb, 1995; Slaughter and Rhoads, 2004).

There is also an international dimension of the literature that can inform a study of state-level science and technology policy. The Industrial Performance Center at the Massachusetts Institute of Technology has been active on a global level, with analyses of the effect of higher education on local economic innovation (Lester, 2005). Two of the most frequently cited examples are Finland (Chakrabarti and Lester, 2004) and the so-called "Celtic Tiger" of Ireland (Harris, 2005; Sweeney, 2000).

This literature often inspires comparisons between successful nations and American states because of the geographic and demographic similarities. For example, Ireland is a relatively small nation of four million people with historically strong agricultural and tourism sectors that made the decision to pursue high-tech economic growth during the 1990s—similar in many respects to states such as Alabama, Kentucky, Louisiana, and South Carolina.

Problem and Purpose of Study

There are many facets to the states' role in science and technology policy. The purpose of this study is to examine one facet in depth: the diffusion of policy innovations, such as state research strategic plans, state science and technology councils, and state cooperative technology programs across states in an effort to understand the factors that influence science and technology policy diffusion and to identify characteristics of states that make them more likely to adopt these policy innovations. The research question that will guide this study is: What are the comparative effects of demographic, economic, and political characteristics of states on their adoption of science and technology policy innovations? By better understanding the policy diffusion process, this

dissertation will hopefully provide some guidance to those states that lag behind in terms of research resources and activity about how they can build their capacity and competitiveness in science and technology.

For the purpose of this dissertation, the general definition of research and development (R&D) is "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture, and society, and the use of this stock of knowledge to devise new applications" (National Science Foundation, 2003; Organization for Economic Cooperation and Development, 2002). As they relate to policy, the terms "research" and "science and technology" are used interchangeably in this text.

Total R&D includes basic and applied research, as well as development, and total R&D expenditures consist of basic and applied research in the sciences and engineering as well as activities in development conducted by the following sectors of the economy: federal government, industry, universities and colleges, other nonprofit institutions (e.g., philanthropic foundations), and federally-funded research and development centers (NSF, 2003).

This study also seeks to make a meaningful contribution to the large and long-standing body of policy diffusion literature, and to add to the small but growing literature on the diffusion of policy innovations related to postsecondary education, which has focused thus far on accountability and financing policies. Finally, by employing event history analysis to the study of science and technology policy diffusion and innovation, this study will also help to affirm the value of this methodology to diffusion studies at the state level.

Significance of Study

Writing in 1951, Harvard President James Bryant Conant observed, "In a democracy, political power is widely diffused. Policy is determined by the interaction of forces generated and guided by hundreds of thousands if not millions of local leaders and men of influence...Because of the fact that the applications of science play so important a part in our daily lives, matters of public policy are profoundly influenced by highly technical scientific consideration. Some understanding of science by those in positions of authority and responsibility as well as by those who shape opinion is therefore of importance for the national welfare" (Conant, 1951, p. 19). From 60 years

ago, Conant's words were an eloquent and prescient call for both greater understanding of science and of science policy.

In 2005 John Marburger, Science Advisor to former President George W. Bush, called for increased scholarly attention to the science of science policy. "I am suggesting that the nascent field of the social science of science policy needs to grow up, and quickly, to provide the basis for understanding the enormously complex dynamic of today's global, technology-based society" (Marburger, AAAS Keynote Address, 2005).

In response to Marburger's call, the National Science and Technology Council created an Interagency Task Force to prepare a "roadmap" for the development of science policy as a field. In late 2008, the White House's Office of Science and Technology Policy released the "roadmap" with the express hope that the field would "...begin to address the need for better scientific theories and analytical tools for improving our understanding of the efficacy and impact of science and technology policy decisions" (Office of Science and Technology Policy, 2008). Since 2006, NSF has awarded grants through its Science of Science and Innovation Policy (SciSIP) program within the Directorate of Social, Behavioral, and Economic Sciences. The increase

in federal attention to the “science of science policy” and the growth of the field as a scholarly discipline point to the significance of this study as it seeks to make a contribution to this emerging area.

Ideas and policies spread, but how? How does the diffusion process work? Without conceptual frameworks and research designs to study this spread, individuals—and governments—are simply passive observers of the diffusion process, unable to test hypotheses and reach conclusions about how diffusion works. If a good idea or policy spreads from one state to another but there is no systematic attempt to explain how or why, the diffusion process remains hidden and mysterious.

States must rely on luck and can only hope that they are doing the right thing, or that they have the right conditions in place, for lightning to strike and policy innovation to occur. With so much riding on states’ capacity for policy innovation, particularly in science and research, a better understanding of the diffusion process is essential. For states, counting on luck and waiting for “policy lightning” to strike in the 21st century global economy is a recipe for disaster.

For many researchers and for the public in general, the policymaking process is opaque. Civics textbooks

explain how a bill becomes a law but the explanation is often idealized and oversimplified, failing to take into account all of the political nuances and personal aspects of the process. Yet at least an explanation, however incomplete, for how a bill becomes a law exists. How do policymakers get ideas in the first place? How do these ideas gain traction with policymakers?

State policymakers operate in a policy environment, or milieu, that is formed and shaped by many factors. For example, the amount of money available for policy experimentation and change is a fundamental influence on the state policy environment. The authority of governors relative to legislators also shape this environment, as does the extent to which legislators have the human resources (i.e., time and staff) to analyze policy and adapt new ideas for their states' purposes. These factors are at work in every state, in every policy domain. Understanding how these factors affect the diffusion of ideas is a crucial first step toward the improvement of the policymaking process.

Of course, state policy environments are not hermetically sealed. Factors and influences flow between these environments and as a result states learn from and follow the examples of each other. The National Governors

Association, the National Conference of State Legislatures, and the Council of State Governments exist primarily to coordinate these interactions between state policymakers and facilitate the diffusion of ideas.

For example, as a result of a state-level policy "learning lab" conducted by the NGA in 2001, West Virginia policymakers learned about Kentucky's efforts to establish a "research challenge fund" to support research projects linked to the state's economic development agenda. During the "learning lab," representatives from Kentucky described their fund, its purpose, and outcomes. Persuaded by the Kentucky experience, West Virginia policymakers returned home and developed a similar fund.

Various regional consortia, such as the Western Governors Association and the Southern Regional Education Board (SREB), use geographic proximity as a means of focusing the diffusion process. Under Governor Zell Miller in the 1990s, Georgia created the lottery-funded HOPE (Helping Outstanding Pupils Educationally) Scholarship to reward high-achieving students and keep them in state for college. Through regular meetings and other outlets organized by the SREB, policymakers from member states received continued exposure to the HOPE scholarship idea—and the Georgia policymakers who championed the effort. It

is not surprising, then, that many other SREB states (Florida, Louisiana, South Carolina, Tennessee, West Virginia) followed suit and created their own merit-based scholarship programs.

The reason for the focused and sustained effort to elucidate and enhance the state role in research and science policy is, in large part, financial. Total research and development expenditures in the United States in 2006 (the most recent year for which complete data is available) was \$340 billion (National Science Board, 2008).

Research is clearly big business, particularly as the economy becomes more knowledge-driven and high-tech based (National Research Council, 1999; Kearns, 2001; Smith and Barfield, eds., 1996). Every state wants a proverbial piece of the action as a way to stimulate economic development through direct grants, job creation, recruitment of existing industries, and the establishments of new industries and companies.

There is, however, an extraordinary concentration of research expenditures and resources in a small number of states. As much as half of U.S. research and development expenditures occur in just six states: California, Michigan, Massachusetts, New York, Texas, and Pennsylvania (Bennof, 2002). According to NSF data, in 2001 the 20

highest-ranking states in research and development expenditures were responsible for 85% of the total, while the 20 lowest-ranking states accounted for just 5% (Shackelford, 2005). This concentration of research wealth and activity in a handful of states only increases the urgency of this issue—at least for states ranked #21 through #50.

For this reason, this dissertation will include a section on the 25 states and two jurisdictions (Puerto Rico and the U.S. Virgin Islands) that participate in NSF's Experimental Program to Stimulate Competitive Research, or EPSCoR, as part of the study's larger discussion of data results and implications. Eligibility for EPSCoR is limited to those states and jurisdictions that receive an average of less than 0.75% of NSF's annual research funding over a three-year period, as measured by NSF's Office of Budget, Finance, and Award Management. These are the states that also rank in the bottom half in terms of research expenditures. As such, understanding the characteristics of innovative diffusion is particularly important to research and science policy efforts in these states.

The diffusion of policy innovations is one major way in which states, especially those with less research

funding and activity, gain new information about science and technology policy "best practices" and seek to improve their research capacity and competitiveness. Given the amount of money states spend each year on research and the increasingly research-oriented nature of state economies, understanding the diffusion of these policy innovations at the state level is a critical next step in doing policy research that has practical applications for the policymaking process.

The NSF has also recognized the inherent potential of science, technology, and research policy to serve as a change agent at the institutional, state, and federal levels. An NSF-sponsored workshop on "Research Policy as an Agent of Change" at the University of Arizona in 2003 concluded that, "Science and technology are integral to major social, political, economic, and environmental transformations, with significant implications at local, national, and global scales...Because research policy influences these processes in myriad intended and unintended ways, the study of research policy and its role as an agent of change merits sustained attention" (NSF, 2005).

The workshop report also observed that, "Research policy is frequently treated as a 'black box' that is not

systematically examined. But because research policy plays such a significant role in contemporary research systems, understanding its operation is of critical importance for informed decision making" (NSF, 2005). By examining the diffusion of research policy innovations at the state level, this dissertation addresses one facet of the much larger research agenda outlined in the workshop report. One of the workshop's primary recommendations is for more research on science and technology policy, and further, to employ diverse methods and disciplinary perspectives in conducting this research. By using event history analysis from a political science/public policy perspective, this dissertation seeks to bring a new tool to this nascent research agenda.

Chapter Two

Literature Review

This chapter provides a review of the literature on the diffusion of innovations. In the most expansive sense of the term "innovation," this literature is both broad and deep. The diffusion of innovations has been studied since at least the early 20th century and across a variety of different academic disciplines. This review begins with a brief survey of general diffusion research, which establishes baseline definitions for key terms used throughout this dissertation: diffusion and innovation.

The chapter then moves to a more focused review of the literature on the diffusion of policy innovations, culled primarily from the field of political science. The review continues to narrow to a consideration of the diffusion of education policy innovations, followed by a look at the small but growing number of studies that have been conducted specifically on the diffusion of postsecondary education policy innovations.

General literature on innovation and diffusion

The most important work on the general study of innovation diffusion is by Everett Rogers, a communications scholar. From the use of steel axes by Australian aboriginals to CAT scanners in American hospitals and clinics, Rogers provides the definitive introduction to the study of how innovations—broadly defined—spread across time, space, and societies. Rogers defines diffusion as “the process by which an innovation is communicated through certain channels over time among members of a social system” and innovation as “an idea, practice, or object that is perceived as new by an individual or other unit of adoption” (Rogers, 1983, p. 5). Subsequent scholars and researchers of innovation and diffusion have relied on Rogers’ definitions of these terms in their own studies. This dissertation will also use these definitions.

Rogers identifies other academic disciplines, besides communication, that helped to build the diffusion research tradition throughout the early 1900s. Among the disciplines represented in diffusion research by the early 1960s were anthropology, education, epidemiology, and sociology. Perhaps the most significant of these early studies comes from the subfield of rural sociology. Ryan

and Gross (1943) conducted a pioneering analysis of the diffusion of hybrid corn seed among Iowa farmers.

Through a survey of Iowa farmers, Ryan and Gross found that the role of individuals and the social networks to which they belong are essential to any study of diffusion. "There is no doubt but that the behavior of one individual in an interacting population affects the behavior of his fellows...The very fact of acceptance by one or more farmers offers new stimulus to the remaining ones" (Ryan and Gross, 1943, p. 20). Thus, the experience of those initial or early adopters of an innovation (such as hybrid corn seed) was highlighted as a major influence on the decision to adopt or not by others. These findings foreshadowed the importance of time and interpersonal networks as factors in the rate and extent of innovation diffusion across many other disciplines, including political science.

Literature on public policy innovation and diffusion

By the late 1960s, political scientists began to embrace innovation diffusion research. However, diffusion study in political science focused more on policies than tools or technologies, and on governmental units (e.g., states) rather than individuals. In one of the first, and certainly one of the leading, articles on the diffusion of

policy innovation among states, Walker observes that "[S]tates have traditionally been judged according to the relative speed with which they have accepted new ideas...If it is true that some states change more readily than others, a study of the way states adopt new ideas might lead to some important insights into the whole process of political change and development" (Walker, 1969, p. 881).

Examining how and when states adopt a range of 88 policy innovations drawn from the Council of State Governments, Walker generated a number of important insights. First, Walker investigated whether policy innovation occurred more readily in states that are more industrialized, urban, and cosmopolitan because of the concentration of creative resources in these states. (In this sense, Walker's work is an interesting precursor to Richard Florida's more recent study of the "creative class" and the tendency of members of this "class" to locate in areas that are more innovative, progressive, and tolerant of social diversity.) Based on hypotheses from political science, Walker also tested the relationships between policy innovations and a variety of state-level political indicators, such as the level of political party competition, the level of legislative professionalism, and turnover in elected offices. In both cases, Walker

affirmed the conventional wisdom that socioeconomic and internal determinants were, in fact, positively correlated with state-level policy innovation. Walker's work has produced substantial thinking and rethinking throughout the diffusion literature ever since.

Building on classic organizational theory that policymakers are limited by their capacity to understand all of the available information on any issue and to evaluate all possible options, Walker further advised students of policy innovation to look at the "rules of thumb," or the "heuristics," that policymakers use to sort through information and to make judgments. According to Walker, the most salient of these "rules" is that state policymakers "look for an analogy between the situation you are dealing with and some other situation, perhaps in some other states, where the problem has been successfully resolved" (Walker, p. 889).

This echoes the findings of Ryan and Gross from a quarter-century earlier about the importance of "early adopters" on the attitudes and behaviors of those who follow. It also confirms an intuitive point, articulated in later policy diffusion research: policymakers, especially elected officials, are generally risk-averse (even more so in an election year), and thus seek to

maximize their chances of being re-elected by only adopting policies that have been proved successful elsewhere.

A third insight from Walker deals with the effect of regionalism on policy innovation. In particular, Walker found that some states served as "regional pace setters" in policy innovation for states in a "regional reference group." Although his data indicates that this effect was less clear and direct than he expected, Walker was able to divide the nation into five regions and demonstrate that, with a few exceptions, states tended to cluster into these "regional reference groups" and that in each group, one or two states stood out as pioneers in policy innovation (Walker, 1969). These states include Florida for the South, Connecticut and Massachusetts for New England, New Mexico for the Mountains and Northwest, and New Jersey for the Mid-Atlantic and Great Lakes.

In addition to regionalism, Walker cited the rise of regional, national, and professional organizations, such as the Council of State Governments and the National Association of State Budget Officers, as a powerful influence on the state policy innovation process. In Walker's estimation, these organizations serve two primary purposes: as sources of information and policy cues and as opportunities for job networking. Thus, the migration of

both ideas and personnel contribute to state policy innovation.

Ultimately, Walker's article focused on sketching a map of what was, in 1969, the relatively new and unfamiliar landscape of state policy innovation research. His identification of key landmarks, such as satisficing, emulation, competition, cuetaking, and regionalism, have guided the development of research hypotheses in this field for almost 40 years, and while subsequent researchers have found evidence supporting some of Walker's theories and not others, his study is still the point of departure for all other diffusion scholars and studies, including this dissertation.

While Walker's work remains a watershed in diffusion studies, much has changed. Over the last 40 years, technological advancements such as the Internet and the expanding role of quasi-governmental organizations such as the National Governors Association have made regional reference groups less influential as they once were. The ability to access policy information electronically, including legislation, executive orders, and policy reports, enables state policymakers to know as much as about what is occurring in a state on the opposite coast as in a state that shares a border. This increase in the

amount and availability of policy information has created more need for organizations that specialize in comparative policy analysis and have the capacity to convene state leaders around specific issues.

Continuing down the trail blazed by Walker, Gray conducted her own study of policy diffusion among the states. She confirmed some of Walker's findings, most notably that one driver of innovation is the interaction between those who have adopted a particular innovation and those who have not, and that the wealth of a state has a positive effect on its level of "innovativeness" (Gray, 1973). In these respects, she was consistent with previous findings on the role of interpersonal networks and also Walker's conclusions about socioeconomic influences on policy innovation.

However, Gray expanded on and clarified some of Walker's other conclusions by examining diffusion patterns by issue, or policy, area. In particular, Gray sought to assess the impact of federal intervention on a state's decision to adopt a policy innovation. "As a result, the pattern of spread for this innovation [state merit systems under the Social Security Act] is somewhat different from that of other welfare policies. These results indicate the necessity for at least distinguishing between state and

state-federal control in this dimension of policy and perhaps distinguishing among various types of federal aid to states" (Gray, 1973, p. 1181).

Gray argued that this disaggregation of innovation study into specific issue areas, such as education, welfare, and civil rights in her own work, provided a more accurate and robust analysis of the underlying forces at work. Gray added to Walker's findings by addressing the possibility that state policy innovation may be time- and issue-specific, depending in part on the extent of federal involvement or intervention. This makes intuitive sense: federal involvement, either through passage of law or provision of funding, is bound to have an effect on the policy innovation process as states seek to comply with new federal directives or to secure additional federal monies. Gray's efforts to disaggregate diffusion into policy areas also reduce the validity of overall state innovation rankings, a prominent part of Walker's efforts. Different states may simply be innovative in different policy areas.

Menzel and Feller (1977) entered the burgeoning debate between Walker and Gray with a study of state-level diffusions of technological innovations. Because of their focus on the adoption of new technologies, such as air telemetry and computer modeling to control air pollution,

Menzel and Feller focused on specific state agencies that had the authority to adopt a new technology, as opposed to state governments generally, which set broad policies but rarely dictate the adoption of particular tools that agencies use to implement those policies. "In effect, we are introducing a new independent variable—jurisdictional responsibility—into the formulation of state innovation studies" (Menzel and Feller, 1977, p. 529).

Through structured interviews with agency-level officials in ten states, Menzel and Feller tested Gray's theory that a state's "innovativeness" is time- and issue-specific and found that technological innovation adoptions, at least, support this theory. They also considered whether interaction between adopters and non-adopters is a useful or meaningful variable in the study of state policy innovation. In contrast to Walker, who identified such interaction between states as a major cause of policy innovation, Menzel and Feller found less of an interaction effect among states related to adoption of new technologies (Menzel and Feller, 1977).

Consistent with Gray's research, Menzel and Feller also found an interaction effect between states and other levels of government—higher (federal) as well as lower (local and municipal). "This diffuseness of interaction

patterns among the states suggests that other factors may blur or otherwise disrupt lateral (state-to-state) cuetaking. Indeed, the interviews indicate that diffusion may be as much a vertical process involving different levels of government as it is a horizontal process" (Menzel and Feller, 1977, p. 534). They identified federal legislation, federal persuasion (i.e., informal guidance or feedback from federal officials), and federal certification and evaluation policies as important elements of this vertical process.

In a separate article from the same year, these same authors offered a new focus for research on policy innovation and diffusion: the "diffusion milieu" (Feller and Menzel, 1977). Citing the limitation of existing approaches, Feller and Menzel argue that there is no single process for diffusion that holds true for all policy domains and innovations, and thus there is a need for a more general understanding of the space in which and the process by which diffusion takes place. "The diffusion milieu may be conceptualized as a source of discrete and continuous changes in relation to a set of adopters" (Feller and Menzel, 1977, p. 52).

Again with a focus on the adoption of technological innovations by state agencies, Feller and Menzel outlined

the components of the "diffusion milieu" that shaped the adopting (or non-adopting) behavior of these agencies: demands for changes/performance gaps; supply of alternatives; agency-executive relationships; suppliers' marketing activities; financial resources available to pay for change; the quality of knowledge networks within agencies to assess alternatives and the consequences of change; impact of intergovernmental relationships; and citizen demands (Feller and Menzel, 1977). Collectively, they argued that these components determine whether a given state agency will adopt a given technological innovation.

Other researchers also explored the interaction between the federal government and state policy innovation and diffusion. In particular, they examined whether policies with federal incentives attached diffuse across states more quickly than policies that do not (Welch and Thompson, 1980). Examining the diffusion rates of 57 different policies, some of which were drawn from Walker's 1969 study, Welch and Thompson considered the effects of both positive and negative federal actions—"carrots" and "sticks." "Carrots," generally in the form of federal funding, stimulated diffusion more quickly than "sticks," generally in the form of federal withholding of funds or regulatory sanctions. Both, however, prompted state

adoption more quickly than no federal involvement. However, multiple regression analysis suggested that federal incentives did not explain a large proportion of variation in policy diffusion rates across states (Welch and Thompson, 1980).

Reflecting the maturation of innovation diffusion as a subfield of policy study, by the early 1980s scholars began to look beyond legislatures and state agencies as the only entities capable of innovation. For example, Canon and Baum (1981) examined the adoption of tort law innovations among state judiciaries. One of their purposes for the article was to inform the ongoing debate between Walker and Gray by offering new evidence from another branch of state government about the extent to which policy innovation adoption is issue-specific.

They concluded that the process of innovation was different in courts than in legislatures because courts are reactive and dependent upon litigants to bring cases in order to have the opportunity to innovate (Canon and Baum, 1981). By contrast, legislatures have greater control over the timing and content of policy agendas. Canon and Baum also did not find much support for a regional effect in tort law innovation across states because communications about legal decisions are much more systematic and diffuse.

"[T]he legal system developed rather early a method for communicating court decisions that is both formally structured and geographically unlimited. Only in the current era are many other political and social systems developing social and technological avenues of information exchange which override geographic barriers" (Canon and Baum, 1981, p. 985).

Publius, a policy studies journal, devoted an entire issue in the mid-1980s to the issue of diffusion in an effort to summarize the "state of the field" since Walker. In his review of the existing literature, Savage observes that almost all diffusion research has focused on one of three units of analysis: individuals, organizations, and geographic units (e.g., states). The literature on policy diffusion, he continues, has dealt primarily with the geographic spread of policy innovations, hearkening back to Walker's notion of regional diffusion (Savage, 1985). He then proceeds to outline the findings of diffusion research across eight topics: policy generation; the policy decision-making process; policy attributes; characteristics of innovative policy adopters; leadership and diffusion networks; change agents; state-level innovation; and the consequences of innovation (Savage, 1985).

In general, Savage concluded that these findings have been helpful to advance the field of study, but some important gaps remain. Among these gaps was the role of policy communities (or issue networks) on policy generation, policy change across states and time, and the effects of policies once they are adopted.

In that same issue, Clark also assesses the state of diffusion research and echoes Savage's point about a major omission in the literature: the change in policy content as policy innovations are adopted across states over a period of time. She contends that the scope of change is at least as important as the rate of change. "One might argue that the major problem of this research tradition is that it reveals nothing about the content of new policies. Its fascination is with process, not substance" (Clark, 1985, p. 63). She points out that not all state policies are similar in their details, even when the issue under consideration is the same and it is clear that states are following, or emulating (to use Walker's term) early adopters.

Acknowledging Clark's point about the importance of studying not only the process but also the substance of policy change, Glick and Hays (1991) conducted a study of state living will laws. "It is unlikely that many

policies...remain unchanged, either throughout a period of diffusion or after most states have initially adopted a program...Instead of a single policy spreading uniformly throughout the states, policymaking may exhibit initial innovation, varied diffusion, and reinvention over time" (Glick and Hays, 1991, p. 836).

Glick and Hays compared early and late adopters of state living will laws, and found that while early adopters may be fairly regarded as "chronological" innovators of a particular policy, late adopters may be, in fact, equally or even more innovative because they "reinvent" the policy. In general, they also found that late adopters tended to change, or "reinvent," living will laws in a more liberal, or "facilitative," direction in response to factors such as new applications of medical technology, changes in the positions and priorities of interest groups, and new patterns of emulation among states (Glick and Hays, 1991). However, not all late adopters made policy changes in a liberal direction. The influence of certain socially or ethically contentious policy provisions, such as withholding food and water from terminally-ill patients, led policymakers in some states to make living will laws more restrictive and less facilitative. Thus, policy change or reinvention can occur in both conservative and

liberal directions as adoptions proceed across time and states.

The field of diffusion study underwent a significant methodological change in the early 1990s with an article by Berry and Berry on state adoption of lottery programs. Berry and Berry (1990) were dissatisfied with the limitations of using just one or the other explanation for state policy innovation, which had dominated the field since Walker and Gray. The first of these explanations, the internal determinants model, focused on the political, economic, and social characteristics of states to account for policy innovation. The second explanation, the regional diffusion model, focused instead on the interaction among neighboring states to predict whether a state would adopt a policy or not.

Berry and Berry dismissed the false dichotomy between the two explanations and suggested that they were not only compatible but in fact needed to be combined in order to produce a more robust explanation of state policy innovation and diffusion. "Furthermore, neither a pure regional diffusion model nor a pure internal determinants model is a plausible explanation of state innovation in isolation" (Berry and Berry, 1990, p. 396). They found that both internal characteristics, such as fiscal health

and proximity in time to the next state election, and the adopting behavior of neighboring states, form a unified model that helps to explain state lottery adoption.

Berry and Berry's substantive findings were eclipsed in importance, however, by their methodological approach. They employed an analytical tool uncommon in political science to the study of state policy innovations: event history analysis, or EHA. By applying this research tool, Berry and Berry hoped to bridge the methodological gap between the internal determinants and regional diffusion models and increase the predictive value of this research. "With EHA, scholars can subject theories of state government innovation to a powerful test by assessing whether these theories can predict the probability that a particular type of state will adopt a particular policy in a particular year...With it [EHA], one might study a wide range of political events and in doing so take advantage of both temporal and cross-sectional variation in political behavior" (Berry and Berry, 1990, p. 411). Berry and Berry's breakthrough in diffusion research design has dramatically shaped the growth and direction of the field since 1990. The next chapter of this dissertation describes EHA in greater detail and justifies its use as

the analytical tool for the study of the diffusion of research policy innovations across states.

To reinforce the value and validity of event history analysis as a policy diffusion research tool, Berry and Berry also applied it to another state policy innovation: tax policy. In the literature on state taxation policy, Berry and Berry identified five general explanations for why states adopt particular tax policies: economic development, fiscal health, election cycle, political party control, and regional diffusion (Berry and Berry, 1992). All five of these explanations emerged from the political science literature; the fifth (regional diffusion) was introduced by Walker as described earlier in this chapter.

After constructing hypotheses and operationalizing the independent variables for each of these five explanations, Berry and Berry tested each using the EHA approach. Many of their substantive conclusions were in agreement with other state tax policy research: the length of time until the next election, an imminent fiscal crisis, and recent tax policy adoptions by neighboring states all are positively correlated with a state adopting a new tax policy (Berry and Berry, 1992). Equally relevant to this dissertation is their call for expanded use of EHA: "...event history analysis should be applied to other kinds of policy

adoptions to assess the general utility of the approach” (Berry and Berry, 1992, p. 739).

In another “state of the field” review, Berry again advocates for EHA as an effective research strategy for policy diffusion. She observes three primary theoretical explanations for why state governments adopt new policies: internal determinants, regional diffusion, and national interaction. She further links the research design that most frequently accompanies each explanation: cross-sectional analysis for internal determinants; factor analysis for regional diffusion; and time-series regression for national interaction (Berry, 1994). She concludes that these three approaches, in isolation from one another, are inadequate in capturing the whole story behind diffusion of policy innovations, and reiterates the value of EHA, which offers an empirical way of testing the combined effects of all three explanatory models.

Literature on education policy innovation and diffusion

Prior to the 1990s, there were only a handful of education researchers engaged in innovation diffusion studies, and all of them were focused on the elementary and secondary levels. By surveying principals, Mort (1953) sought to determine the best predictor of public school

innovation; he found that the answer was educational costs per pupil. About a decade later, Carlson (1965) conducted a major study on the diffusion of an innovative mathematics curriculum among schools in West Virginia and western Pennsylvania. Collecting data through interviews with school superintendents, Carlson found that only after the "opinion leaders" among the professional network of superintendents adopted the math curriculum did other superintendents follow (Carlson, 1965).

By the late 1990s, researchers began to consider the diffusion of state educational policy innovations (as opposed to school- or district-level innovations, which generally revolved around the curriculum). Building on Berry and Berry's use of EHA, Mintrom (1997) studied the diffusion of school choice policies at the state level. Specifically, Mintrom wanted to determine the effect of "policy entrepreneurs" on the consideration and adoption of school choice policies by state legislatures. He defined policy entrepreneurs as "people who seek to initiate dynamic policy change through attempting to win support for ideas for policy innovation" (Mintrom, 1997, p. 739).

Mintrom found that these policy entrepreneurs, who were identified through survey responses by state education officials and policy leaders, were a significant influence

on getting the school choice issue onto the agendas of state governments. He drew a distinction, however, between legislative consideration and legislative adoption, and the influence of policy entrepreneurs at the adoption stage was greatly diminished. His EHA models demonstrated the countervailing effects of other factors, such as student test scores and the opposition of teachers' unions, at the adoption stage (Mintrom, 1997). Ultimately, he concluded that policy entrepreneurs were more effective in raising the school choice issue than getting school choice laws passed.

As an incremental step from work on policy entrepreneurs, Mintrom and Vergari (1998) utilized the same data and research design on school choice policies to examine the effect of "policy networks" on innovation and diffusion. They define policy networks as "a group of actors who share an interest in some policy area and who are linked by their direct and indirect contacts with one another" (Mintrom and Vergari, 1998). Although the discipline of political science led in the identification of policy networks, or communities, Mintrom and Vergari observed that the study of these networks has generally not extended to their role in state-to-state diffusion of policy innovations.

Based again on an EHA analysis of state adoption of school choice laws, they found that policy networks did contribute to the diffusion of this innovation. Their research, however, suggested that there are in fact two kinds of policy networks: internal and external. External policy networks are issue-specific and consist of individuals with a shared interest in a particular policy innovation. Internal networks are also issue-specific but are comprised of individuals who have well-established connections to the policymaking community. Mintrom and Vergari found that the salience of these two types of networks depends on the stage in the policy process. External networks are more important during the legislative consideration of a particular policy innovation, while internal networks are more relevant when the time comes for actual legislative adoption of a policy (Mintrom and Vergari, 1998).

Literature on higher policy innovation and diffusion

The study of policy innovation (but not diffusion) in postsecondary education began in the mid 1990s with Hearn and Griswold (1994), who examined the effect of state higher education governance structures on policy innovation. Specifically, they considered the following

nine policies as examples of innovations: undergraduate assessment, testing of teaching assistants, college savings plans, prepaid college tuition plans, taxed or restricted college businesses, criminality of vandalism of animal research buildings, alternative teacher certification, and prohibiting education majors from becoming high school teachers. For the purposes of their study, Hearn and Griswold defined innovation as a policy that "potentially affects the enterprise significantly and meets our criterion of being a substantive, non-marginal change in policy relating to postsecondary education" (Hearn and Griswold, 1994).

Consistent with the substantial body of political science literature, they also assessed the influence of states' internal determinants (i.e., population, educational attainment, and socioeconomic development). Based on these five factors, Hearn and Griswold created six hypotheses; they expected that postsecondary education policy innovation would be positively associated with centralization of governance, higher population, greater affluence, educational context (i.e., graduation and attendance rates), and the presence of one or more innovative neighboring states.

Using bivariate descriptive and multiple regression analyses on data drawn from a variety of secondary sources, they found that governance structure was a significant factor on the more academically-oriented of the innovation policies: undergraduate assessment, testing of teaching assistants, and prohibiting education majors from becoming high school teachers, as well as the regulation of college businesses. A state's size, wealth, and educational context all produced mixed and limited results. While Hearn and Griswold did find a pronounced regional effect for each innovation studied, there was a substantial difference across regions in terms of the direction of the policy behavior.

Only recently have researchers folded the element of diffusion into the study of postsecondary policy innovation. McLendon, Heller, and Young (2005) ventured forth into this subfield with a call for a new, practical research agenda. "Nonetheless, the question of state policy innovation in postsecondary education may inform the enduring debate about the best way to organize public postsecondary systems and to promote knowledgeable policy development within those systems—whether through centralized (i.e., strong state-level direction) or decentralized (i.e., maximum campus or market control)

state governance arrangements" (McLendon, Heller, and Young, 2005, p. 365).

They conducted a study of six postsecondary education policy innovations (college savings programs, prepaid tuition programs, merit-based scholarship programs, performance funding, performance budgeting, and undergraduate assessment) that gained prominence throughout the 1980s and 1990s. They identified four sets of explanations from the innovation literature: centralization of governance, internal socioeconomic determinants, internal political determinants, and policy diffusion (regional cuetaking and emulation).

Following the template of Hearn and Griswold, McLendon, Heller, and Young drew on these four explanations to create a series of eight hypotheses about the ways in which these explanations would relate to the policy innovations under consideration. In summary, they expected that states with centralized governance structures, higher populations and greater wealth, more professional legislatures, stronger governors, more inter-party competition, single party control of the legislature, innovative neighbors, and closer in time to the next election cycle would be more likely to adopt postsecondary policy innovations (McLendon, Heller, and Young, 2005).

Using a logistic regression model to analyze the effects of the independent variables on the dichotomous outcomes (whether a state adopted a given policy innovation or not), the authors found mixed results. Overall, the models explained anywhere from 11.5% of postsecondary accountability innovation outcomes (performance funding and budgeting and undergraduate assessment) to 32.3% of postsecondary financing innovation outcomes (college savings, prepaid tuition, and merit-based scholarship programs). They also found that Republican legislative control, the presence of innovative neighbors, and the number of years since a state's last postsecondary education policy innovation were significant influences on adopting policy innovations in general and financing innovations in particular.

Combining this base of postsecondary education policy diffusion and innovation with the methodological tools first suggested by Berry and Berry, McLendon, Hearn, and Deaton (2006) applied the event history analysis (EHA) approach to a study of state performance and accountability policies. Relying on much of the same conceptual framework that guided the study of postsecondary accountability and financing innovations by McLendon, Heller, and Young in 2005, the authors examined the effect of a state's

demographic, economic, organizational, and political characteristics, as well as regional diffusion, on its likelihood of adopting one or more of three postsecondary performance-accountability policies (i.e., performance funding, performance budgeting, and performance reporting).

Specifically, they formulated ten hypotheses drawn from the political science and innovation literature. They expected states with lower educational attainment, lagging economies, more professional legislatures, greater Republican legislative control, stronger governors, Republican governors, rapid growth in undergraduate tuition and enrollment levels, more centralized governance structures, and innovative neighbors to be more likely to adopt these performance-accountability policies (McLendon, Hearn, and Deaton, 2006).

Using EHA, McLendon, Hearn, and Deaton produced mixed results. None of the hypotheses held true for performance reporting, generally the least intrusive and stringent of the three innovations. A state with Republican control of the legislature and a less centralized governance structure was more likely to adopt the performance funding policy innovation. However, a state without a Republican-controlled legislature and a more centralized governance

structure was more likely to adopt the performance budgeting policy innovation.

Perhaps the most intriguing part of the study by McLendon, Hearn, and Deaton is their reconceptualization of the effect of governance structure on policy innovation adoption. "We now view governance arrangements as serving to institutionalize the preferences of different sets of stakeholders, which seek to shape policy consistent with their preferences" (McLendon, Hearn, and Deaton, 2006, p. 19). They suggest that a more centralized governance system (a consolidated governing board) is more closely linked to the "academic cartels" of system and campus academic administrators and thus more likely to protect the interests of the system and campuses from encroachment on their autonomy. As a result, consolidated governing boards may adopt, or urge the adoption by legislators, of performance budgeting as a less intrusive or stringent alternative to performance funding.

McLendon, Deaton, and Hearn (2008) extended the use of EHA in state higher education policy with a study of governance reform in the 1980s and 1990s. Specifically, they tested the "political instability hypothesis" to see if instability in political institutions (such as rapid turnover in gubernatorial and legislative leadership) could

account for states' likelihood to undertake higher education governance reforms.

The authors developed nine hypotheses, each designed to measure some dimension of political instability. These dimensions include partisan legislative control, length of gubernatorial tenure, state economic conditions, and undergraduate enrollment trends, among others. This array of variables is a useful way to identify the various sources of instability within state political institutions.

Bridging the worlds of postsecondary and K-12 policy studies, McLendon and Mokher (2008) used EHA to examine states' adoption of dual enrollment policies. Featuring an array of ten hypotheses, their study tested the effects of various characteristics such as postsecondary enrollment growth, the existence of state P-16 councils, and the extent of Republican legislative control on the likelihood that states promulgate dual enrollment policies.

The study found a number of statistically significant factors affecting dual enrollment policy adoption: two-year enrollments, the presence of a consolidated governing board, Republican control of the state legislature, and the existence of a broad-based merit scholarship program. Interestingly, the study did not find evidence that the existence of a P-16 council had a significant impact,

despite the fact that these entities are explicitly designed (in most states) to facilitate a more "seamless" system of education from preschool through postsecondary education.

Hearn, McLendon, and Mokher (2008) continued the application of EHA to higher education with an examination of states' adoption of student unit-record (SUR) systems. Modeled on their previous studies, the authors set forth ten hypotheses that capture a variety of state characteristics and dynamics, ranging from the size of a state's population and the percentage of the population between the ages of 18-24 to the extent to which a state has a citizenry with a liberal ideology and the popular support for Libertarian candidates for president.

The findings support the hypothesized relationships between population (as well as the percentage of the population between 18-24) and student unit-record policy adoption, suggesting that these SUR systems are appealing to states with more students to track and manage. Whether a state was undergoing federal civil rights monitoring also positively affected the likelihood states adopted SUR systems, perhaps reflecting the extent to which such a system enables states to collect and report civil rights data more effectively to the federal level.

Summary and synthesis of literature review

The preceding literature review offers a number of clear lessons in terms of creating a conceptual framework for examining the diffusion of research policy innovations across states. Tracing the literature back to Walker, the pioneering diffusion researcher in political science, virtually every study has relied on a combination of both internal determinants and regional diffusion to hypothesize and explain policy diffusion. In most studies, these models have consisted of both political and socioeconomic indicators, or variables. As diffusion studies began to focus on specific issues and policy domains, such as state lottery programs or charter schools, researchers also began to include more issue-specific variables. In studies dealing with education, for example, additional education-specific variables assumed to have an effect on innovation adoption (e.g., governance structure or teachers' union opposition) have been added to the models. An inventory of these variables, ranging from Walker in 1969 to McLendon, Hearn, and Young from 2006, is provided in Figure 1.

Figure 1. Independent variables in policy diffusion studies, 1969-2006

author(s) and (year)	independent variables
Walker (1969)	<ul style="list-style-type: none"> • % of population urban • total population • per capita income • value added by manufacturing, per capita • average value of farms, by acre • % of population illiterate • median school years completed • inter-party competition • legislative malapportionment • legislative professionalism • elected office turnover • region in which state is located
Canon and Baum (1981)	<ul style="list-style-type: none"> • total population • % of population urban • % of state economy in manufacturing
Berry and Berry (1990 and 1992)	<ul style="list-style-type: none"> • fiscal health/per capita income • % of population urban • % of population religious fundamentalist • extent of single party political control • number of contiguous states "adopting" • % of contiguous "adopting" states • proximity to election year
Mintrom (1997) and Mintrom and Vergari (1998)	<ul style="list-style-type: none"> • % of education funding from state • student test scores • % of private schools • number of other educational reforms • proximity to election year • extent of single party control • opposition of teachers' unions • number of contiguous states "adopting" or "considering"
Hearn and Griswold (1994)	<ul style="list-style-type: none"> • total population • region in which state is located • level of socioeconomic development • level of educational attainment • postsecondary governance structure
McLendon, Heller, And Young (2005)	<ul style="list-style-type: none"> • postsecondary governance structure • total population • median income • higher education enrollment rate • % change in higher education enrollment rate • extent of single party control • legislative professionalism • inter-party competition • proximity to election year • number of contiguous states "adopting" • average years since "adopting" by contiguous states
McLendon, Hearn, and Young (2006)	<ul style="list-style-type: none"> • postsecondary governance structure • educational attainment rates • fiscal health • legislative professionalism • extent of Republican legislative control • gubernatorial strength • Republican control of Governor's Office • rate of undergraduate tuition and enrollment increases • number of contiguous states "adopting"

As this summary demonstrates, there are precedents in the relevant literature for incorporating a wide range of variables into models designed to examine policy diffusion.

There are, however, some variables of greater conceptual interest than others for this particular study. This study incorporates variables related to wealth, political power, legislative professionalism, and gubernatorial power into a conceptual framework for explaining policy innovation. Because of the focus on research policy, which is closely linked to the processes and outcomes of postsecondary education, there is additional reason to include variables related to postsecondary educational attainment and governance structure.

The following figure identifies those variables and provides a brief explanation for their relevance to this study of the diffusion of science and technology policy innovations. A further discussion of each variable is included as part of the hypotheses in chapter four.

Figure 2. Synthesis of independent variables from literature review

Independent variable	Explanation of conceptual relevance
State wealth/income	However wealth is measured, economists believe it is the result of industrialization and economic specialization. How are greater industrialization and economic specialization related to science and technology policy innovation? As the economy shifts to a post-industrial era, in which intellectual capital is more important than labor and physical capital, is it possible than industrialization may be negatively correlated with policy innovation?
Political party control of legislature	Political scientists have long contended that political parties matter because they are mechanisms for transmitting political values, organizing governance efforts, and enforcing partisan discipline. Given that adoption of policy innovations is an inherently political process, it is essential to consider the effect of parties on this process.
Legislative professionalism	Thanks to the pioneering work of Squire, legislative professionalism has been quantified and can be included in explanatory models. In some ways, this variable might be even more important than party control as legislators' capacity (regardless of party) to understand complex issues and make policy based on their understanding becomes a driving force in the political process.
Gubernatorial power	Thanks to the work of Beyle, gubernatorial power has been quantified and can be included in explanatory models. Because the American system of democracy is based on the existence of separate and equal legislative and executive branches of government, this variable serves as a critical counterpoint to the legislative variables.
Postsecondary education attainment	This variable serves as a useful way to measure the capacity of a state's population to think critically about policy issues and make more cogent and sophisticated demands on elected officials for innovative policies.
Postsecondary governance structure	The way in which a state structures its governance of postsecondary education is a manifestation of policymakers' trust and confidence in postsecondary institutions and their leaders. Introduced by Hearn and expanded by McLendon, this variable is a powerful way to study the influence of postsecondary education on policy decisions and innovation.
EPSCoR status	Policymakers at the state and federal levels have been concerned about a lack of capacity in science and research in certain states. If policy innovation is one way to build this capacity, then focusing on the adopting (or non-adopting) behaviors of these states may shed light on the factors that promote (or inhibit) innovation.

The dependent variable for this study is a state's decision to adopt one or more science and technology policy innovations, defined in chapter four. Based on the literature review as outlined in chapter two, the independent variables for this study are a state's economic condition, political determinants, and postsecondary education landscape (comprised of postsecondary education attainment and postsecondary education governance structure).

Although not a policy diffusion study, Tandberg's dissertation on the relationship between states' political attributes and support for public higher education is well worth noting (Tandberg, 2007). Tandberg's sophisticated approach to operationalizing these political attributes, particularly aspects of political culture that defy easy analysis, can be adapted to studying science and technology policy innovation.

Recognizing that the state appropriations process for public higher education is complex and not particularly well-understood, Tandberg attempts to explain the impact that a broad array of political and economic attributes, such as higher education governance structure, policymakers' partisan affiliation, gubernatorial budgetary

authority, legislative professionalism, and gross state product, have on this process.

In Tandberg's study, most of the political variables did have a statistically significant effect on state higher education appropriations. Among the most interesting findings was that both in terms of the amount of appropriations relative to a state's per capita personal income and higher education's share of the state general fund budget, greater legislative professionalism and more centralized governance structures resulted in a better outcome (more money and a greater share) for higher education.

Chapter Three

Research Design and Framework

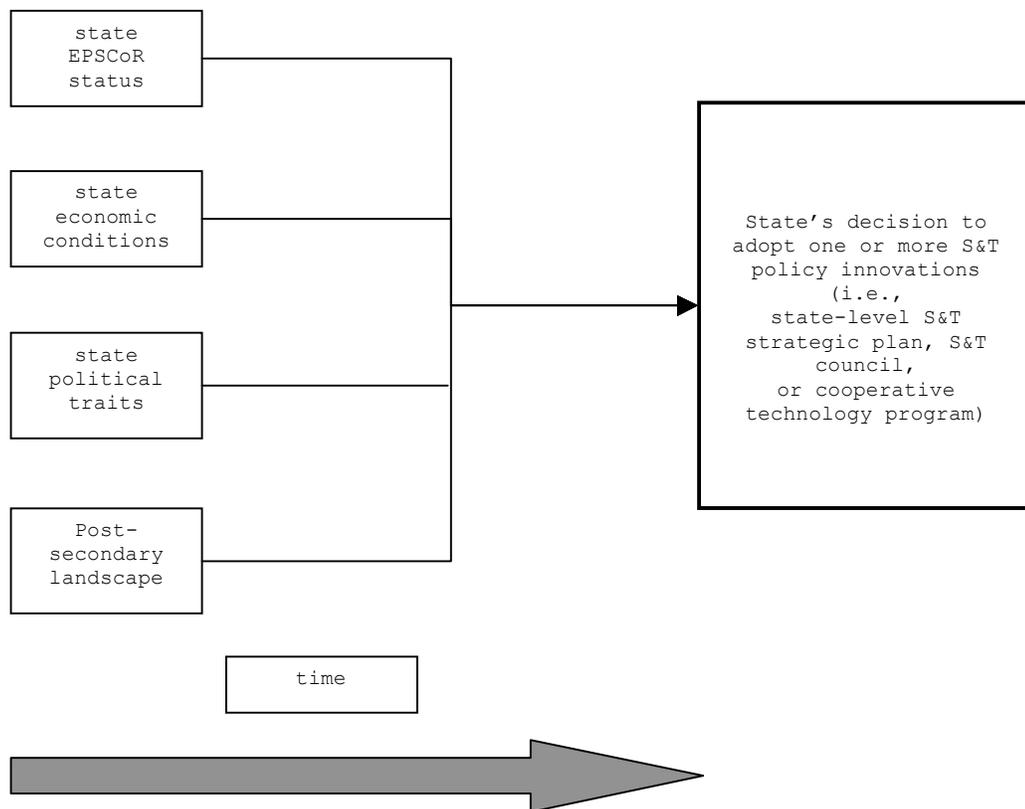
As the preceding literature review demonstrates, political scientists have been interested in the diffusion of policy innovations for at least 40 years. These innovations have come in a wide variety of policy domains, from transportation and health care to environmental protection and economic development. The diffusion of a particular policy innovation is driven by the decisions of individual states to adopt that policy innovation—to “make it their own,” typically through legislation or executive order.

Put simply, if states do not adopt a policy innovation, there is no diffusion. If multiple states do adopt a policy innovation, there is at least some measurable diffusion, which raises the inevitable question: why? Why have multiple states adopted this policy innovation? What are the factors that led to adoption? What factors inhibit the adoption of policy innovations? In academic and economic markets, where innovation in

science and technology policy is increasingly important to success, these questions are more important than ever.

The fundamental research question of this study is: What are the comparative effects of demographic, economic, and political characteristics of states on their adoption of science and technology policy innovations? The expected relationship between the independent and dependent variables is depicted in the conceptual framework below.

Figure 3. Conceptual framework for study



This conceptual framework is based on the synthesis of the literature review as displayed in Figure 3. As in previous studies, the variables can be defined into one broad heading: internal determinants, which are the demographic, economic, political, and educational characteristics. Comparing the significance of these different factors and characteristics on policy adoption will produce a rank order of relative effects. In politics, not all factors and characteristics have equal salience in the policy adoption process. Depending on the state, the time period, and the innovation, different factors and characteristics will be more or less significant. In the aggregate, however, this study should provide policymakers with a glimpse into the arrangement of the contents in the "black box" or, to use John Kingdon's phrase, the "garbage can" of the policy process.

Hypotheses

This study will test the following hypotheses:

- Hypothesis 1. The greater a state's wealth, the more likely it is to adopt science and technology policy innovations.

Wealth has been conceptualized by some researchers as "slack" or "free-floating" resources." "Slack resources

refers to people, time, and money being made available for the express purpose of looking for better ways to do things." (Donaldson and Bell as quoted in Feller and Menzel, 1977, p. 64) In the case of states, "slack" can mean having more money available to afford research policy innovations, which can be expensive in terms of increased state appropriations for research and for the institution where it is conducted. It can also mean having more time available to consider research policy innovations—time that other, less affluent states must devote to solving problems such as health care and corrections policy that wealthier states have already addressed (if not solved). The "people" dimension of "slack" resources is more appropriately dealt with as part of Hypothesis 4 on public governance structures.

- Hypothesis 2. The extent to which a state's legislature and Governor's office is controlled by one party is positively correlated with that state's likelihood of adopting science and technology policy innovations.

As identified in recent studies, this is the "institutional control" hypothesis that suggests a government unified under one party has fewer political, or

partisan, roadblocks and less policy gridlock, and thus can move quickly to adopt policy innovations (McLendon, Heller, and Young, 2005). These researchers did not initially hypothesize about the effect of the particular party in control (i.e., Democratic or Republican), but they did find that a Republican-controlled legislature was strongly and positively correlated with adoption of one or more postsecondary education policy innovations, especially financing innovations.

The direction of an effect based on party is an interesting question. On one hand, the Republican Party is generally regarded as more aggressive in terms of creating public-private partnerships to facilitate research activity, compelling universities to work more closely with industry, awarding research and development tax credits, and viewing an issue like research through the lens of economic development (as an applied, rather than a basic, endeavor). On the other hand, the Democratic Party is more frequently associated with increases in state funding for institutions (in part to pay for research facilities and activities), creating programs to recruit new faculty researchers and graduate students to state institutions of higher education, and recognizing the importance of basic research and the generation of new knowledge as a

fundamental and inherently valuable mission of research universities. Given the nearly balanced scale on this point, this dissertation will follow the "institutional control" hypothesis and expect to find an effect based on party control without specifying a direction based on party.

- Hypothesis 3. States with greater degrees of legislative professionalization are more likely to adopt science and technology policy innovations.

Legislative professionalization is determined by the extent to which a legislature meets on a full-time basis (as opposed to a part-time or biennial basis), is compensated accordingly, and has a sufficiently large and specialized staff (Squire, 1993). The importance of these characteristics was highlighted by a study on the science and technology policy supports available to state legislatures (Jones, Guston, and Branscomb, 1996). This study produced three key findings: state legislators need more policy support in sorting through the ocean of technical information available on science and technology policy; state legislators currently rely on state government structures such as joint research offices, legislative libraries, and specialized staff for aid with

technical information; and according to legislators, the most important qualities of information sources were trustworthiness and accessibility. Based on these findings, it is reasonable to expect that those legislatures with greater professionalization, specialized resources, and available staff (the "people" dimension of "slack" resources as referenced in Hypothesis 3) are leaders in research policy innovation.

- Hypothesis 4. States with governors who have more authority are more likely to adopt science and technology policy innovations.

Governors' institutional power has been quantified by Beyle as a combination of six factors: the extent to which other executive branch officials are elected separately; tenure potential (for example, a governor's eligibility to serve consecutive terms); appointment power in major policy areas such as K-12 education and health; budgetary authority; veto power; and whether or not a governor's party also controls the state legislature (Beyle, 1999).

Although Beyle's conceptualization of gubernatorial power is widely used and highly regarded, it is not without potential problems. For example, Beyle's model generally regards the term limits as a check on governors' power. In

some cases, however, term-limited governors come into office with a more robust agenda and greater expectations from voters precisely because they only have one term in which to bring change. In Virginia, where governors are limited to one term (they may sit out one cycle and then run again), Mark Warner created a sense of urgency around his agenda from 2002 to 2006 and won major policy battles in areas ranging from tax reform to high school redesign.

Although Beyle consistently ranks West Virginia's Governor as one of the powerful, in part because of that governor's substantial appointment power, again there are nuances worth noting. For example, West Virginia's Governor appoints members (with Senate confirmation) to the State Board of Education. At first glance, this would seem to give the governor greater power over education than governors in states with different approaches to selecting state K-12 leadership (for example, 10 states elect state board members). However, while the governor has the power of appointment, the term length of state board members in West Virginia is nine years—a duration designed to insulate the state board from the cycles of electoral politics—and so the governor's apparent power is mitigated. Taking into account these and related caveats, Beyle's index remains a

very useful and insightful method of assessing and comparing gubernatorial power.

Since science and technology is a relatively recent issue on the state policy radar screen, it is reasonable to expect that a leadership vacuum exists on this issue in many states. At the same time, numerous external sources—from the federal government to private foundation to business executives—are all pointing to the need to harness science and technology as engines of tech-based economic development. Given these conditions, strong governors are likely to see science and technology as a policy domain ripe for action.

- Hypothesis 5. Designation by the National Science Foundation as an EPSCoR state makes a state more likely to adopt science and technology policy innovations.

This hypothesis takes the “regional/neighbor” diffusion effect one step further by examining the extent to which membership in national networks, instead of exclusively geographic location, affects innovation adoption. Deaton (unpublished dissertation, 2006) hypothesized that states’ memberships in regional consortia, such as the Southern Regional Education Board or

the Western Interstate Commission for Higher Education, positively influenced their decision to adopt policy shifts related to tuition because these consortia serve as “a conduit for dissemination of state policy.” For the purposes of this study, a very significant national network of states is the Experimental Program to Stimulate Competitive Research (EPSCoR), a program of the National Science Foundation that provides funding to build research capacity in states that historically receive less than 0.75% of NSF’s annual R&D budget. This hypothesis is based on the assumption that states’ lack of NSF grant funding is a powerful impetus to adopt policy innovations that may increase competitiveness for grant support.

- Hypothesis 6. The greater a state’s postsecondary educational attainment rate, the more likely it is to adopt science and technology policy innovations.

This hypothesis is complementary to Hypothesis 1 in the sense that a more highly-educated citizenry is more likely to expect policies that encourage research and stimulate intellectual and economic development. Citizens who are college-educated are more likely to support both policy and budgetary innovations in higher education, in part because they assign personal value to higher education

based on their own experiences as students and in part because they recognize the greater societal benefits of a robust higher education system. These benefits, often derived from research, include better health care, more jobs, a cleaner environment, and safer transportation.

- Hypothesis 7. States with more centralized postsecondary education governance structures are more likely to adopt science and technology policy innovations.

Research on the effect of postsecondary governance structures on policy innovation has produced mixed results. Hearn and Griswold found a positive relationship between more centralized governance structures and academic policy innovations, such as requiring assessment of undergraduates (Hearn and Griswold, 1994). More recent studies found that less centralized postsecondary governance structures were more likely to adopt financing policy innovations (McLendon, Heller, and Young, 2005), while more centralized structures were more likely to lead to the adoption of performance-budgeting policy innovations (McLendon, Hearn, and Deaton, 2006).

If these authors are correct in their provocative reconceptualization of centralized governance structures as

protecting the interests of “academic cartels” of system and university administrators, then this dissertation expects to find a positive relationship between greater centralization of governance and the likelihood of adopting research policy innovations. In most cases, research policy innovations should be not only supported but actively pursued by universities, especially research universities (which tend to have the most political clout and strength in any state system of higher education and the most to gain). Thus, centralized governance systems will represent and protect those interests by advocating for the adoption of such innovations.

Explanation of conceptual framework

Based on the conceptual framework, the following section breaks down the research question into its component parts, including an explanation of the dependent and independent variables.

EPSCoR status

Dating back to Walker, “regionalism” or “regional diffusion” has been a major part of policy diffusion studies. Regionalism has an intuitive appeal as an explanation for policy diffusion; it makes sense for states that share a border to have an effect on one another. The

border is, after all, an artificial political construction. People, ideas, media coverage, and money all flow across state borders with ease and influence political dynamics on a constant basis. If one state experiences success because it adopted a particular policy innovation, news of that success spreads quickly to its neighbors and may prompt those neighbors to take similar action in the hopes of enjoying similar success.

“Regional” refers to geographic contiguity, or at least to geographic proximity. With the proliferation of quasi-governmental organizations such as the National Governors Association (NGA), the National Conference of State Legislatures (NCSL), and the Council of State Governments (CSG), however, “regionalism” has likely lost some of its explanatory power. The explicit mission of these organizations is to serve as a clearinghouse about state policy research and actions so that the details and results (good and bad) of a policy adopted in Maine can be shared with policymakers in Hawaii through conferences and newsletters which serve as conduits for information. Thus, the time it took to share information across states, regardless of their geographic location, decreased. The time necessary to share information decreased again with an increase in the power of technology. Today, most states’

entire statutory code and full text of executive orders are available online. NGA, NCSL, CSG, and other comparable organizations send regular e-mail updates about policy changes and maintain online policy databases that are readily searchable.

States want to learn from each other, and these state policy organizations fulfill that purpose. States are very complex organizations, however, and despite the work of these intermediary organizations, the sheer variety and quantity of state policy actions can often create impediments to policy diffusion. Therefore, additional organizations have emerged around specific policy domains to filter the variety and quantity of state policy actions and channel that information to the appropriate people in each state.

In education policy, the Education Commission of the States (ECS) is a good example. As its name suggests, the organization focuses on education and provides education policy information to states. Thanks to ECS, governors' education policy advisors and states' legislative education committee staffers can bypass the "shopping malls" of information at NGA and NCSL and go directly to "specialty stores" of education information at ECS.

There are very few organizations that focus on state science and technology policy information. The most renowned is the State Science and Technology Institute (SSTI). As more and more states recognize the importance of science and technology as a policy area (as evidenced in part by the burgeoning number of governors' science advisors and legislative science and technology committees), it is reasonable to expect additional organizations like SSTI to emerge to meet a growing need for specific policy information.

Another mechanism that replaces regionalism and can draw states together around common policy issues is a federal grant. In science and technology policy, perhaps the best example is the coalition of 25 states (and two territories) that participate in the Experimental Program to Stimulate Competitive Research (EPSCoR) grant program. This program, initiated by the National Science Foundation (NSF) in 1980, has grown to include comparable programs in seven federal agencies. Although NSF has the oldest program, the largest EPSCoR-like program, called IDeA (Institutional Development Award), is located at the National Institutes of Health.

By virtue of receiving comparable grant awards from federal agencies to build science and research capacity,

these states have formed a community that meets annually and advocates collectively on behalf of EPSCoR and EPSCoR-like programs with Congress. As with NGA or NCSL, geographic location is not important in EPSCoR; participating states literally range from Maine to Hawaii, with every region of the country represented. The common denominators among these states are a traditional lack of competitiveness for federal research dollars and a shared goal of building research capacity and becoming more competitive. These common denominators have been sufficiently compelling to create a network of states that can serve as a vehicle for policy diffusion.

Demographic, economic, and political characteristics

Some of the most apparent differences (and similarities) across states are their demographic, economic, and political characteristics. From the very first U.S. Census, states have been ranked according to their population. Atlases and almanacs always contain information about where a state ranks in terms of its size in square miles. The media uses "red" and "blue" as colorful shorthand to describe the political leanings of states as either Republican or Democratic. Virtually every report on the standard of living or quality of life in states uses per capita income as an indicator. In all of

the diffusion studies from political science, some set of these characteristics are used to assess the differential effects of indicators such as population or per capita income on diffusion.

In general, the demographic characteristics are based on race/ethnicity, sex, and education attainment. Of these, this study will use only education attainment. Economic characteristics often boil down to median income. Political characteristics usually reflect the political landscape of a state in terms of the extent of partisan power in the executive and legislative branches, the degree of competitiveness between parties, and legislative professionalism. The expected relationships between these characteristics and science and technology policy innovations are described below in the hypotheses for this study. Race/ethnicity and sex are not included in this study because very few, if any, policy diffusion studies in the last 20 years have included these variables.

Policy adoption

The word "adoption" has a specific meaning in policy diffusion studies. It implies a conscious decision on the part of policymakers to choose and implement a particular policy option. Their choice is most frequently exercised through the passage of legislation or the issuance of an

executive order. In this study, either of these two actions constitutes "adoption." One key to using legislation or an executive order as evidence of adoption is the ability to be precise (at least within a year) in identifying the time of adoption. Absent such a conscious action taken by a policymaking body, specifying the time of adoption is more difficult. For this study, precision in identifying the time of policy adoption is important because of the use of event history analysis as the research methodology.

Science and technology policy

Why science and technology policy? As states have shifted from agrarian economies in the 19th century to industrial economies in the 20th century and now to knowledge, or innovation, economies in the 21st century, science and technology has come into its own as a policy domain demanding the attention of state policymakers.

As outlined in the first chapter, this is a policy domain where states have become increasingly important players after two centuries of federal dominance. Indeed, for many years science and technology—unlike education and health care—was not perceived as a policy domain. Instead, science and technology were seen as tools to achieve certain goals in other policy domains. For example,

experimentation and development of new equipment were keys to improving agricultural production and medical research was essential to improving the quality of health care.

The professionalization and specialization of science and the rapid growth in technology have transformed science and technology into policy domains in their own right, complete with questions among state policymakers about the best ways to foster scientific research, to organize technology services, and to coordinate state activities and resources in support of science and technology. Increasing specialization and complexity in science and technology have also overwhelmed the ability of policymakers to make sense of (and thus to make policy decisions about) phenomena such as climate change and discoveries such as genetic engineering.

Policy innovation

Finally, there is the word "innovation." Rogers (1983) defined innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption." This definition emphasizes "newness" as the distinguishing feature. A reasonable addition to this definition is that there is an expectation that the "idea, practice, or object"—in other words, the innovation—will have a salutary effect on a particular problem or issue.

Otherwise, why would anyone (or any state) adopt the new idea or practice? Change requires an investment of resources, whether time, money, energy, or all three, and no rational actor would make such an investment without the expectation of a positive return on that investment. The word "innovation" has a strong connotation of progress, problem-solving, and improvement.

This study considers three policy innovations related to science and technology: state-level strategic plans, state-level councils, and state-level cooperative technology plans. Although strategic plans have become almost banal as ways for businesses and organizations to build consensus and focus their efforts, such plans are relatively recent in state-level science and technology policy. In part this is because science and technology, as discussed above, has only recently become its own policy domain at the state level.

It is also because states have only recently recognized the relationship of science and technology to economic growth and the need, therefore, to think systematically about ways to build scientific and technological capacity to promote growth. State-level science and technology strategic plans represent a policy innovation not only because they are new ideas or practices

for states, but also because they represent a new way of thinking for states about previously disconnected entities and efforts. A strategic plan is an example of an idea under Rogers' definition.

Likewise, science and technology councils (or comparable groups that go by other names) are ways to organize these previously disconnected entities. These councils are new objects—new boxes on an organizational chart—in many states and thus are innovations for this purposes of this study. These councils also represent a way of creating new and ongoing interactions among units as disparate as academe, business, government, and philanthropic foundations. Presumably, these interactions will lead to positive change for the state. In some ways, a council can be thought of as an object under Rogers' definition.

A state cooperative technology program is a way that states can formalize, or codify, partnerships among academe, business, and government to commercialize concepts from scientific research (more commonly known as tech transfer). These partnerships may exist on an *ad hoc* basis, but a state program either provides new mandates or financial incentives for the official creation of such partnerships, often establishes guidelines for their

operation, determines accountability measures for their continuation, and may exempt such partnerships from regulatory requirements elsewhere in statute or policy to further facilitate their work. These programs are the result of a conscious decision of state policymakers to encourage this kind of partnership for the state's benefit. Because these programs contain new state policies and change the way entities behave, they are an example of a practice under Rogers' definition.

To illustrate some of the practical details of these innovations and to provide greater definition of the dependent construct, two anecdotal examples of each innovation are provided below.

State strategic plans for science and technology

In 2000, Idaho Governor Dirk Kempthorne commissioned the development of a comprehensive strategic plan to make Idaho competitive in the "new economy." The governor charged the Idaho Science and Technology Advisory Council, which had been established in 1999, with taking the lead on preparing the plan. The Council contracted with the Battelle Memorial Institute as a consultant to the planning process. Funding to pay for Battelle's involvement was provided by various sources, including the Idaho Department

of Commerce, Idaho's small business development centers, the Idaho Department of Water Resources, and the Bechtel Corporation subsidiary in the state. The report's recommendations clustered into six areas: workforce development; university-industry collaboration; technology commercialization; entrepreneurial culture; transportation and telecommunications needs; and a public outreach campaign about the importance of science and technology.¹

In 1991, the Maine legislature requested a state-level strategic plan for science and technology from the Maine Science and Technology Foundation, a nonprofit organization (State Science and Technology Institute, 1997). Released in 1992, the Maine plan was entitled *Maine's Science and Technology Plan: A First Step Toward a Productive Future*. One of the required elements of the plan was a focus on economically distressed areas and how disparities among different regions of the state could be reduced. This statewide focus on equity was likely a result of the legislative process, in which no policymakers wants his or her district to be overlooked. In addition to improving K-12 education and workforce development, the plan also made World Wide Web access a major priority by recommending

¹ More information about Idaho's 2001 science and technology strategic plan is available on the web: <http://labor.idaho.gov/news/PressReleases/tabid/294/ctl/PressRelease/mid/1047/ItemID/1646/Default.aspx>.

continued investment in Internet technologies and services in the University of Maine system. The plan further called for all businesses and communities in Maine to develop their own web sites.

State science and technology councils

Not surprisingly, one of the nation's largest and most sophisticated science and technology councils is in California. The California Council on Science and Technology (CCST) was created by legislation in 1988. The legislation gave substantial latitude in identifying members, saying only that the council's membership should be comprised of distinguished scholars and experts, including scientists and engineers from California's academic and industrial community. The charge given by the legislature to the council was equally broad. The CCST was expected to "identify long-term research needs for sustaining the state's economic development competitiveness...assess private sector/university relations and technology transfer...and analyze public policy issues involving science and technology..." (California Assembly Concurrent Resolution 162, 1988).

Perhaps the most interesting characteristic of the CCST is its mandated relationship with higher education, both public and private. While the council *responds* to the

governor, legislature, and other entities, it reports to the presidents of the University of California, the University of Southern California, the California Institute of Technology, Stanford University, and the Chancellor of the California State University system.

Also in 1988, the Bluegrass State established the Kentucky Science and Technology Corporation (KSTC). The KSTC is a private, non-profit organization with a board of directors drawn from academe, business, and government. According to the corporation's website, its mission is "enhancing the capacity of people, companies, and organizations to develop and apply science and technology and compete responsibly in the global marketplace." While Kentucky's system of higher education is well represented on the KSTC board, it has an equally strong business and industry orientation. In addition to managing Kentucky's EPSCoR program and its state Science and Engineering Foundation, KSTC's portfolio also includes K-12 education efforts such as the Appalachian Rural Systemic Initiative to boost math and science performance among poor and rural Appalachian students, and the Kentucky's National Math

Science Initiative to increase student access to Advanced Placement courses in math and science.²

State cooperative technology programs

One of the oldest and most successful cooperative technology programs is Ohio's Thomas Edison Program. This program was established in 1983 under the leadership of Governor Dick Celeste, who is regarded as a leading proponent of expanded state roles in science and technology policy. The Edison Program is a statewide network of non-profit organizations, mainly technology centers and incubators, which provide services to high-tech business to help them generate more products, jobs, and companies. The services fall into four categories: product innovation and commercialization; process innovation; business assistance; linking research to in-state applied innovation. The Ohio Department of Development, the state agency responsible for economic development efforts, oversees the Edison Program.³

Another successful example of a cooperative technology program is the Ben Franklin Partnership in Pennsylvania. Created in 1983, the partnership provides the following

² More information about the Kentucky Science and Technology Corporation is available on the web: <http://www.kstc.com/>.

³ More information about Ohio's Thomas Edison Program is available on the web: <http://www.odod.state.oh.us/tech/edison/>.

services to entrepreneurs and high-tech businesses: risk capital investment; business and technical assistance; and building networks among universities, federal laboratories, and research institutions. The partnership operates from five regional centers located throughout the state, each with its own leadership. According to an external evaluation of the partnership's effectiveness from 1989 to 2001, the return on the state's investment was \$23 in private and/or external funds for every \$1 in state funding. In total, the Ben Franklin Partnership is credited with adding \$8 billion to the Pennsylvania state economy since the late 1980s.⁴

⁴ More information about Pennsylvania's Ben Franklin Technology Partnership is available on the web: <http://www.benfranklin.org/>.

Chapter Four

Research Methods

Definition of variables

The dependent variables in this study are dichotomous: whether a state adopted a science and technology policy innovation or not. This study focuses on three particular state-level policy innovations: science and technology strategic plans, science and technology councils, and cooperate technology programs. These innovations were selected because each represents fundamental recognition by state policymakers of the importance of science and technology as a policy domain.

This study relies on Rogers' definition of an innovation: "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1983, p.5). Using this definition is consistent with other, more recent policy innovations studies such as Walker, who defined an innovation "as a program or policy which is new to the states adopting it, no matter how old

the program may be or how many other states may have adopted it" (Walker, 1969).

Each innovation is also a deliberate attempt by policymakers to provide or organize state resources in support of science and technology. While there are literally dozens of state science and technology policy actions that can be defined as innovations, these three (described in Figure 4) have been adopted in enough states over a long enough period of time to allow for a robust analysis. An analysis of additional policy innovations is one direction for further study in this area.

Figure 4. Descriptions of dependent variables

research/S&T policy innovation	Brief definition	number of states and earliest (starting) years
state-level strategic plan or report card for research and development in science and technology fields	a plan, mandated by legislative statute or gubernatorial executive order, that articulates and/or measures progress toward a state's long-term strategy for building research capacity and securing additional research funding	n = 28 starting year = 1992
state science and technology council (or comparable entity, such as an authority, board, commission, foundation; for the purposes of this dissertation, these terms are interchangeable)	a council, created by legislative statute or gubernatorial executive order, that advises state officials on the formulation and implementation of state science and technology policy	n = 43 starting year = 1981
state cooperative technology program	a program, created by legislative statute or gubernatorial executive order, that establishes partnerships among academe, government, and industry to facilitate technology transfer	n = 50 starting year = 1983

The independent variables in this study are seven demographic, economic, and political characteristics (or

internal determinants). The seven independent variables are: (1) state per capita income, (2) single party control of state legislature, (3) legislative professionalism, (4) gubernatorial power, (5) postsecondary educational attainment rate, (6) postsecondary education governance structure, and (7) participation in EPSCoR.

Once again, there are numerous characteristics that can be studied to determine their effects on states' decisions to adopt policy innovations. These characteristics were selected based on a thorough review of the policy diffusion literature from political science and higher education policy. Each characteristic, with the exception of EPSCoR status, has been used by at least two previous studies in this area. The inclusion of EPSCoR status as an "internal determinant" represents an original contribution to the literature. The independent variables are drawn from the literature review and described in Figure 5.

Figure 5. Definition of independent variables

independent variable	definition/method of operationalization
state income	state per capita income, based on U.S. Census data
political party control	condition of one party controlling both houses of a state legislature, based on data from the Council of State Government and the National Conference of State Legislatures
legislative professionalism	measure combining legislators' salaries, staff sizes, and length of regular legislative sessions, based on data collected by King and Squire
gubernatorial power	governors' authority based on six factors as collected and analyzed by Beyle

postsecondary educational attainment	percentage of a state's population 25 years and older with at least a baccalaureate degree
postsecondary governance structure	a state's governance structure, based on McGuinness' typology
EPSCoR (Experimental Program to Stimulate Competitive Research) status	designation as eligible for the EPSCoR program by the National Science Foundation

Research Strategy

This dissertation will employ event history analysis (EHA) as its primary research strategy, following the examples of the leading policy diffusion studies (Berry and Berry, 1992 and 1990; McLendon, Hearn, and Deaton, 2006). Using EHA, researchers can examine the relationship between two essential issues: (1) the timing of the transition of entities from one state of being to another; and (2) the factors—and the variation in these factors over time—that affect the timing of that transition. EHA is also a compelling tool because it enables an examination of the effects of both internal determinants and regional diffusion, as opposed to single-explanation methodologies (Berry, 1994). This dissertation, however, focuses on internal determinants. A direction for future research would be to assess the extent technology and the rise of national organizations have reduced the influence of regionalism.

EHA was initially developed as an analytical tool in biostatistics, in which the “event” is generally death and

the "history" is the observed survival time of subjects being studied. Thus, in EHA it is essential to know both if and when an event has occurred. The "hazard," the most important variable in EHA, describes the relationship between the "failure time," indicating the time at which a subject experienced an event, and the covariates of interest (DesJardins, 2003; Box-Steffensmeier and Jones, 2004).

For example, researchers may be interested in the effect of a drug treatment on patient survival. In this case, the dependent variable would be the length of time between the start of the study and the time at which a patient dies. The explanatory variable, or covariate, would be the drug treatment. The research question might be: What is the relationship between the drug treatment and the length of time a patient survives? Does a drug treatment prolong life or hasten death?

In this example, the study period may conclude before all of the patients die. Obviously, at some point those patients will pass away but if their deaths do not occur within the study period, they are considered "censored" in EHA jargon. These patients did not make the transition during the time period being studied, and so data points for these patients are "censored," or missing. More

specifically, this is an example of "right censoring," meaning that the missing data points would be to the right of a line drawn marking the conclusion of the study period. In this case, the space to the right of that line represents the time *after* a study period.

In adapting EHA to the social sciences, the "event" is usually not death but rather the transition from one state of being to another, such as from a state of peace to a state of war. For example, political scientists collect data on the starting and ending dates, as well as the durations, of military interventions between countries and then use EHA as an analytical tool for understanding a nation's "risk" of becoming involved in a military intervention (Box-Steffensmeier and Jones, 2004). A good example from postsecondary education is the collection of data on the state performance and accountability policies and the use of EHA as a tool for understanding a state's "risk" of adopting such policies (McLendon, Hearn, and Deaton, 2006).

In this study, an "event" is a state's adoption of one of three science and technology policy innovations (the dependent variables). Phrased differently, the event is the transition from not having a science and technology policy innovation to having that innovation. Thus, each

state could have experienced a total of three "events," or science and technology policy innovation adoptions. However, not every state adopted all three policy innovations. The "history," or failure time, for each state is the duration of time between the starting point of the observations (for each innovation, a year before any state had adopted that innovation, when all states were "at risk" for experiencing the event) and the year during which a state experienced the event (or adopted the innovation). In EHA terms, the proportion of surviving units decreases as units fail, or experience an event, over time.

The observational period for each policy innovation will begin in the year of the first adoption of that innovation by a state, so the observational periods for each innovation may begin in different years and be of different durations. For the state science and technology strategic plan innovation, the starting year is 1992 when multiple states adopted these plans. For the state science and technology council innovation, the starting year is 1981 when two states created such councils. For the state cooperative technology programs innovation the starting year is 1983, when seven states adopted this particular policy innovation.

For EHA, the data is coded in a binary fashion for each year under analysis—a “0” for each year in which the event did not occur, leading up to a “1” for the year in which the event (the adoption of a policy innovation) did occur. Once a state experiences an event (adoption of a policy innovation), it is removed from the dataset. If a state does not experience an event during the study period, it is coded as a series of zeroes.

This study will use a discrete-time model. This approach is well-suited to a study that focuses on the relationship between the covariates (e.g., state population and postsecondary governance structure) and the hazard (the “risk” that each state will adopt a particular policy innovation). The discrete-time model will also allow measurement of whether a state adopted one or more of the three research policy innovations in a particular calendar year.

“In most analyses of state policy adoption, however, the crucial issue is *not* knowing exactly when adoption (the “event”) occurred within a legislative session, but rather when adoption occurred relative to other states. In such analyses, the year in which a policy was adopted may be sufficient to demarcate the occurrence of an event” (Box-

Steffensmeier and Jones, 1997, pp. 1423-1424, emphasis in the original).

For the purposes of this study, there are two actions that constitute adoption of a policy innovation: the passage of a piece of legislation or the issuance of an executive order. The timing of these actions can be easily identified by year, regardless of the exact day or month the actual vote on passage took place or the order was signed. Since this study focuses on the diffusion of policy innovations among states, the timing of a state's adoption relative to other states is a more critical piece of information.

The adoption of each policy innovation by a state is considered a non-repeatable event in this study. While some states may have added to or changed a policy innovation, the focus of this dissertation is the initial adoption of these innovations, so changes to the policies subsequent to its adoption are not part of the scope of this study.

Using an EHA model, this study will examine the hazard for the adoption of the three science and technology policy innovations (the dependent variables). This model can be formally expressed in the following way:

$$h(t) = 1 - \exp [-\exp (x\beta)]$$

In this model, $h(t)$ is the hazard of policy adoption and x and β are co-efficient to be estimated. As described earlier, the hazard is the fundamental variable in EHA. The hazard, also known as a conditional failure rate, "gives the rate at which units fail (or durations end) by t given that the unit had survived until t " (Box-Steffensmeier and Jones, 2004). In this study, the units are states and the "failure" is the time at which a state adopts the policy innovation.

With three different policies under consideration, this study uses three separate equations (with the same form) in order to test the hypothesized relationships between policy adoption and the specific demographic, economic, or political characteristics. The form for each equation is the following:

$$\begin{aligned} ADOPTION_{i,t} = & INCOME_{i,t} + LEGCTRL_{i,t} + LEGPROF_{i,t} \\ & + GOVPOWER_{i,t} + PSEATTAIN_{i,t} + GOVSTRUC_{i,t} + EPSCOR_{i,t} \end{aligned}$$

In this equation, $ADOPTION_{i,t}$ is the hazard for the policy innovation adoption for a particular state (i) in a particular year (t). $INCOME$ is the state's per capita income, $LEGCTRL$ is the condition of one political party controlling both houses of a state's legislature, $LEGPROF$ is the degree of professionalization for a state's legislature, $GOVPOWER$ is gubernatorial power, $PSEATTAIN$ is

the percentage of a state's population 25 years or older with a bachelor's degree, GOVSTRUC is a state's postsecondary education governance structure, and EPSCOR is a state's participation in the National Science Foundation's EPSCoR.

Study Population

In this dissertation, the unit of policy adoption is the state government. Therefore, states comprise the units of observation. This study uses the internal determinants model to examine diffusion. As a result, all 50 states are included in this study.

Many policy diffusion studies consider some sort of regional effect on diffusion, based on either geographic contiguity or proximity of states. In these studies, Alaska and Hawaii are excluded because they have no contiguous American states as neighbors and thus can not be tested for the regional diffusion effect. The practice of omitting these states for this reason is common in policy diffusion studies (Berry and Berry, 1990; McLendon, Hearn, and Deaton, 2006).

Since this dissertation does not examine regional effects, Alaska and Hawaii are included in the study population. This is important to note because both states

participate in EPSCoR. This study examines EPSCoR participation as an alternative to contiguous adopting states. As described elsewhere in this study, EPSCoR consists of a national network of 25 states (and two jurisdictions), ranging literally from Maine to Alaska. Although these states are far-flung geographically, they share communications through national meetings, program publications, regular contact among state project directors, and a common point of contact with the EPSCoR Office at NSF. Therefore, this study looks at the effect of participation in this network on diffusion and policy innovation. The underlying assumption is that participation in EPSCoR (or comparable networks of states based on factors other than geography) is at least as important as regional proximity.

Data Sources

Data for the dependent variables was drawn from multiple sources. Original policy documents from all states were examined to determine if and when states adopted one or more of the policy innovations. These documents included copies of state strategic plans, minutes and rosters from state council meetings, annual reports, promotional materials, news clippings, and text of

legislation and executive orders. Most of these documents were graciously made available for study by the State Science and Technology Institute (SSTI), which maintains an extensive archive of state science and technology policy information at its Columbus, Ohio, office.

This document review was supplemented by an online search for relevant documentation on each state's official website and by a review of reference materials, both online and in print, from organizations that focus on state policy (e.g., the National Governors Association, the National Conference of State Legislatures, and the Council of State Governments) and science and technology policy (e.g., the Division of Science Resource Statistics at the National Science Foundation and the Public Policy unit of the American Association for the Advancement of Science). For state cooperative technology programs, a comprehensive published study of these programs by Coburn and Berglund (1995) was very helpful.

Data for the independent variables was also compiled from a variety of sources. State per capita income and postsecondary education attainment rates were drawn from U.S. Census data. Data on political party control of state legislatures came from the "State Partisan Balance, 1959-

2004" database developed by Professor Carl Klarner.⁵ Data on legislative professionalism was provided in an e-mail to the author by Professor Peverill Squire.⁶ For gubernatorial power, data was drawn from an online database compiled and maintained by Professor Thad Beyle.⁷ The postsecondary education governance structure data was taken from a typology and index created by McGuinness. A list of states participating in EPSCoR and their year of entry into the program was drawn from the NSF EPSCoR website.⁸

The inclusion of EPSCoR participation is intended to offer an alternative to geographical contiguity in this diffusion study. Contiguity has been the traditional way in which to study regional effects in the diffusion process because proximity has been regarded as key to the transmission of ideas. However, with technological change and increased travel—the so-called “death of distance”—states are transcending purely geographic factors and aligning themselves based on demographic and economic similarities.

As the topic of this study is science and research policy innovation, one of the most relevant organizations is EPSCoR, which effectively splits the states into two

⁵ This database is available at http://www.ipsr.ku.edu/SPPQ/journal_datasets.shtml.

⁶ This data is available as part of an article by Professor Squire in *State Politics and Policy Quarterly*, Vol. 7, No. 2 (Summer 2007): pp. 211-227.

⁷ The URL for Professor Beyle's website is <http://www.unc.edu/~beyle/gubnewpwr.html>.

⁸ This list is available at <http://www.nsf.gov/od/oia/programs/epscor/statewebsites.jsp>.

categories: those that receive significant federal support for R&D and those that do not. One goal of this study is to examine characteristics that make it more (or less) likely for states to innovate, which in turn has consequences for their ability to win federal research funding. The inclusion of EPSCoR participation allows for examination of topical groupings of states, as opposed to contiguous groupings, as a factor in diffusion. This represents both a methodological improvement as well as a substantive area of new inquiry.

In the results section of the dissertation, the following data will be presented: the empirical hazards, by year and policy innovation; descriptive statistics, including means and standard deviations, for each independent variable; and an analysis that models the effects of the independent variables on the hazard of states adopting the policy innovations. The discussion section of this study will address whether the data confirms or rejects the hypotheses and possible explanations for the presence (or absence) of relationships between the independent and dependent variables.

Chapter Five

Results and Analysis

For ease of reading, the data in this chapter is organized by dependent variable, or policy innovation after an initial discussion of the hazard, which is fundamental to any event history analysis. There are three innovations: state science and technology councils, state science and technology strategic plans, and state cooperative technology programs. Analysis and discussion on each innovation follow the presentation of the results.

Before turning to the dependent variables and results, however, the following section provides descriptive statistics and definitions for the seven independent variables in this study.

Figure 6. Descriptive statistics for independent variables

Variable	Mean	Standard deviation	Minimum	Maximum
Govpower	3.546955	.5363517	2.0	4.8
Govstruc	.8133013	.3898257	0	1
Legprof	.2010793	.1278385	.027	.659
Income	20640.58	7673.214	6573	48032
Legctrl	.6089744	.4282332	0	1
Pseattain	23.23786	5.134762	10.9	38.7
Epscor (not a time-varying variable)	.3157051	.4649824	0	1

"Govpower" is gubernatorial power, measured using Thad Beyle's index of six factors that comprise a governor's

institutional powers. These six factors are (1) number of separately elected executive branch officials, (2) tenure potential, (3) appointment power, (4) budgetary power, (5) veto power, and (6) whether the governor's party is the majority party. These factors are scaled from a low score of 1 to a high score of 5. These scores are added across all categories and this total is divided by six, providing an average power score between 1.0 and 5.0. Beyle did not compile his index on an annual basis, so the scores used in this analysis are from 1980, 1988, 1994, 1998, 2001, and 2005. For intervening years, the score from the previous scored year is used.

The minimum score is a 2.0, occurring in South Carolina in 1980. This score reflects the strong role of the Legislature and its unwillingness to share power with the governor. "The South Carolina General Assembly, while recognizing the virtues of consolidating the budget proposal process, was not willing to escalate the governor's profile as an agent for affecting budgetary or policy recommendations" (Carter, 1996, p. 186).

This dynamic of strong legislative control held steady in South Carolina until the early 1980s, when Richard Riley was elected as governor. In addition to securing passage of a constitutional amendment that allowed him to serve a

second consecutive term, Riley also increased his appointment power. As a result of these changes in South Carolina politics over time, gubernatorial power—like all of the independent variables except EPSCoR status—is a time-varying variable.

The maximum score is a 4.8, occurring in New York in 1980. The governor at the time was Hugh Carey, who was elected governor in 1974 after serving seven terms as a U.S. Representative from New York. In addition to the power derived from his high profile and experience in elected office, Carey benefited from conditions that ranked the New York governor's position very high on most of Beyle's factors—scores of 5 on tenure potential, appointment power, budgetary power, and veto power in the 1980 index.

"Govstruc" is the postsecondary governance structure for each state, as defined by McGuinness (1997). McGuinness' taxonomy identifies two basic structures, arrayed on a continuum of centralization. At the centralized end of the continuum are consolidated governing boards, which have direct authority policy and budget authority for higher education institutions. At the other end of the continuum are advisory agencies, which have little or no direct authority over institutions but instead

advise institutions on one or more aspects of the state budget and policy process.

In the middle of the continuum are coordinating boards and planning agencies, both of which vary widely across states in their scope of authority. For the purposes of this study, this variable is dichotomous to capture the fundamental distinction between more centralized structures (governance and coordination) and less centralized (planning and advisory) in terms of state postsecondary structures. States with governing or coordinating structures are coded as 0, while states with planning or advisory structures are coded as 1. Based on the years in which McGuiness assessed each state's structure, this designation is made for each state for the following years: 1985, 1990, 1994, 1997, and 2002. While most states' postsecondary education governance structures are static over time, some changes occur between assessments. For example, both Delaware and Florida had advisory/planning boards in 1990 and 1994, but switched the consolidated/coordinated boards in 1997 and 2002.

"Legprof" is legislative professionalization for each state, as measured by Squire (2003, 2007). Squire's scale runs from 0 to 1.0, with 1.0 being most professional. The key factors in Squire's assessment of legislative

professionalism are whether a legislature is full-time or part-time, legislators' levels of compensation, and the size and resources of legislative staff. Professionalism increases with more regular and frequent legislative sessions, higher compensation, and larger, better equipped legislative staff.

The low score on this measure is a .027, the most recent score for the New Hampshire Legislature. This score is hardly surprising, given that New Hampshire has the shortest legislative session (45 days), legislators only serve on a part-time basis, and their annual compensation is \$200. The high score on this measure is a .659, occurring in New York in 1986. New York's Legislature effectively meets year-round, members are full-time, individual and committee staff sizes are among the nation's largest, and they typically ranks in the top five in terms of annual compensation.

The mean across states is a .201, suggesting that on average, legislators are part-time, poorly compensated, and under-staffed—a situation that has serious implications for policy innovation. Squire's scoring of legislatures occurred in 1980, 1986, 1996, and 2003. States' scores vary across these years primarily because of changes in legislative compensation levels and staff sizes. The third

factor in Squire's system, length of legislative session, rarely changes for any state.

"Income" is annual per capita personal income, in current dollars, for each state. This variable ranges from a low of \$7,007 in Mississippi in 1980 to a high of \$48,032 in Connecticut in 2005. This variable changes each year for each state based on U.S. Census data.

"Legctrl" is a measure of the majority party in the state's legislature each year. This is a dummy variable, with 0 reflecting Republican control and 1 indicating a Democratic majority. In those years when control was split between the parties (either a bicameral division of power between parties or, much more rarely, a tie in the actual numbers of legislators), the state is coded as a 0.5. With each election year comes the potential for change in this variable for each state, as party control swings back and forth. This is true for many states, although there are some exceptions at both ends of the political spectrum during the study period, from reliable Democratic control in Massachusetts to equally consistent Republican dominance in Wyoming.

"Pseattain" is a measure of each state's postsecondary education attainment, defined as the percentage of people 25 years of age or older who hold a baccalaureate degree.

This variables ranges from a low of 10.9% in West Virginia in 1980 to a high of 38.7% in Connecticut in 2005. Again, attainment rates vary by year in each state.

"Epscor" is a dummy variable indicating whether a state qualifies for participating in the Experimental Program to Stimulate Competitive Research (EPSCoR). States in this program receive less than 0.75% of the total NSF research and development budget, indicating their relative lack of competitiveness for federal research funding. On this variable, non-EPSCoR states are coded as 0 and EPSCoR states are coded as 1. This variable does not vary over time; once states begin participation in EPSCoR, they remain in EPSCoR. There is no change in their status.

Hazard

The hazard is the fundamental, unobserved dependent variable in event history analysis. "One may interpret the hazard as reflecting the risk an object incurs at any given moment in time, given an event has not yet occurred" (Box-Steffensmeier and Jones, 1997). Since the hazard expresses the relationship between the risk set and the number of events, the rate is calculated by dividing the number of events in a given year by the number of units in the risk set in that same year.

For each of the following tables, the study period begins with the year when the first event, or policy adoption, occurred. An important consideration in EHA is determining the start time for the analysis of events. "It is critical for the researcher to have a theoretically sound reason for hypothesizing when a social process for an observation can begin, i.e., when does time start? This involves the notion of 'being at risk'" (Box-Steffensmeier and Jones, 1997). The first chapter of this study outlined a brief history of the role of states in science and technology policy. The states did not begin playing a role in science and technology policy until after World War II, and it was only in the 1970s that states' role became significant and sustained.

By the late 1970s, states were seeking ways to address the opportunities and challenges of the rapidly emerging science and technology policy domain. State interest in science and technology led to the proliferation of strategic plans, councils, and collaborative technology programs throughout the 1980s and 1990s. Thus, this study begins in 1980 to capture the history of relevant state actions and events.

The number of events subtracted from the risk set of each year provides the risk set for the following year.

For example, if the risk set in 1980 was 50 and there were five events recorded in 1980, the risk set for 1981 would be 45.

The number of events is recorded by year; a "0" indicates no event occurred in that year. The column of cumulative events provides a running total of events. The hazard is calculated for each year and is independent of the cumulative total. In each year's calculation, the dividend is the risk set, the divisor is the number of events, and the quotient is the hazard, expressed as a decimal between 0.0 and 1.0.

Hazard and EHA results

Science and technology strategic plans

Table 6 contains the data on the hazard for states' adoption of science and technology strategic plans, one of the three policy innovations in this study. The first adoptions occurred in 1992, when six states established strategic plans for science and technology. The year 1994 saw an equivalent hazard—there was one less event but also a smaller risk set. After a six-year lull, the hazard jumps again in 2000 and 2001. An interesting difference between this table and subsequent tables for the other

dependent variables is the absence of state strategic plans in the 1980s.

Figure 7. State Science and Technology Strategic Plans, 1992-2002

Year	Risk Set	Number of events	Cumulative total	Hazard	States
1992	50	6	6	0.120	CT, IA, KS, ME, MT, NM
1993	44	2	8	0.045	GA, MD
1994	42	5	13	0.119	CO, IL, UT, VT, WY
1995	37	3	16	0.081	NJ, NC, TN
1996	34	0	16	0.000	
1997	34	3	19	0.088	AK, RI, WV
1998	31	2	21	0.065	LA, TX
1999	29	1	22	0.034	CA
2000	28	3	25	0.107	HI, MS, NY
2001	25	3	28	0.120	AZ, ID, NH
2002	22	0	28	0.000	

Figure 8 displays the statistical results of the EHA for science and technology strategic plans.

Figure 8. Discrete-time EHA of adoption of science and technology strategic plans

independent variable	exp(B)	SE
Income	0.999	0.000
Political party control	1.264	0.766
Legislative professionalism	1.795	0.392
Gubernatorial power	0.973	0.615
Postsecondary attainment	1.096	0.090
Postsecondary governance	1.501 *	1.047
EPSCoR	1.264 *	0.162
* significant at the .05 level		

This study found statistically significant relationships between two of the covariates of interest—postsecondary education governance structure and EPSCoR status—and the decision by states to adopt science and technology strategic plans. As hypothesized, states with more centralized postsecondary governance structures were more likely to adopt science and technology strategic plans. One logical explanation for this relationship is the “academic cartel” theory (McLendon, Hearn, and Deaton, 2006). According to this theory, more centralized governance structures tend to “institutionalize the preferences of faculty and administrators.” In other words, centralized governance structures reflect the interests of academic, as opposed to political, stakeholders. It is reasonable to conclude that academic stakeholders support science and technology strategic plans for a couple of reasons.

First, strategic plans are often a first step in making the case to elected officials that more state support (primarily in the form of additional appropriations but also in the form of increased operating flexibility, especially in research administration) is necessary. Academic officials can use strategic plans to call attention to gaps in funding and policy, and then offer

recommendations for how those gaps can be addressed. Policymakers are at least somewhat more likely to consider requests for additional support and/or policy change if these requests are articulated in a well-reasoned plan, as opposed to *ad hoc*, poorly substantiated begging.

Second, strategic plans can help to unify different sectors of a higher education system behind a common vision. By definition, state-level strategic plans in higher education are (almost always) consensus documents that identify the differentiated needs and roles of institutions, and thus, the differentiated actions that should be taken to meet these needs. The fact that these plans are built on consensus means that they contain "something for everyone"—a benefit or perk desired by each constituent institution. To the extent that institutions of a higher education system ever share an agenda and work in concert toward a common goal, a statewide strategic plan can make such a "unity agenda" possible. Always looking for reasons to reject requests for additional support, policymakers seize upon disagreement among institutions as a reason to delay action or deny requests. A strategic plan makes institutions appear more unified.

The influence of EPSCoR status on states' adoption of science and technology strategic plans seems to be an

example of the axiom, "necessity is the mother of invention." For EPSCoR states, the historic lack of competitiveness and federal research funding in science create the necessity for coordinated thought and action at the state level. That necessity drives invention, or in this case, the adoption of a policy innovation such as a science and technology strategic plan because such a plan is perceived to be an effective way to increase competitiveness. While every state wants to increase its competitiveness for federal research grants, that impulse is understandably stronger among EPSCoR states. Non-EPSCoR states have more success on which to build and thus less motivation to innovate or adopt new policies.

Science and technology councils

Table 8 contains the hazard data for states' adoption of science and technology councils. The first events occurred in 1981, beginning a steady stream of state activity which ended with two consecutive years of no events in 1994 and 1995. Both 1983 and 1987 were banner years for the establishment of state science and technology councils. The comparatively high hazard for 1999 is in large part the result of a small risk set; by that year, there were only eight states without these councils and so three events in that year produce a large hazard.

Figure 9. State Science and Technology Councils, 1981-2002

Year	Risk Set	Number of events	Cumulative	Hazard	States
1981	50	2	2	0.040	NC, NY
1982	48	1	3	0.021	IN
1983	47	6	9	0.128	AR, CO, HI, MO, SC, WA
1984	41	4	13	0.097	MA, NJ, OH, VA
1985	37	3	16	0.081	ME, MT, OR
1986	34	1	17	0.029	MS
1987	33	5	22	0.151	KS, MN, OK, SD, WY
1988	28	3	25	0.107	AK, CA, KY
1989	25	2	27	0.080	CT, IA
1990	23	2	29	0.087	NV, WI
1991	21	2	31	0.095	NH, ND
1992	19	2	33	0.105	FL, GA
1993	17	4	37	0.235	IL, TN, UT, VT
1994	13	0	37	0.000	
1995	10	0	37	0.000	
1996	10	2	39	0.200	LA, WV
1997	8	0	39	0.000	
1998	8	0	39	0.000	
1999	8	3	42	0.375	AL, ID, TX
2000	5	0	42	0.000	
2001	5	0	42	0.000	
2002	5	1	43	0.125	AZ

Figure 10 displays the results for state councils.

Figure 10. Discrete-time EHA of adoption of S&T councils

independent variable	exp(B)	SE
Income	0.999	0.000
Political party control	1.348	0.932
Legislative professionalism	5.477	0.155
Gubernatorial power	1.668 *	0.932
Postsecondary attainment	1.068	0.962
Postsecondary governance	2.116	0.173
EPSCoR	0.298	0.198
* significant at the .05 level		

In terms of the second policy innovation—the creation of state science and technology councils—there was one statistically significant relationship with a covariate: gubernatorial power. The direction of the relationship between adoption and gubernatorial power was as hypothesized: states with more powerful governors are more likely to create such councils.

No distinction was made in this study among instances of a single innovation, i.e., between a council created by a governor through executive order and one created by legislation. This is an important distinction, however, and one direction for further research would be to run separate models along these lines.

Every governor has the authority to issue executive orders, although state constitutions prohibit governors from using these orders to overturn or substitute for the legislative process. (In his assessment of gubernatorial power, Beyle analyzes differences in governors' appointment powers in major functional areas of government but not differences in governors' capacity to issue executive orders.) Within these constitutional bounds, some governors use the authority more than others; in some cases, governors may regard executive orders as a way to

work around the longer, more cumbersome process of introducing, defending, and compromising on legislation.

As a result, some governors may be reluctant to issue orders—even if they are constitutional—for fear of alienating legislators, most of whom expect to be active, equal partners in the governance process. Some governors, on the other hand, like to issue executive orders precisely because they are a quicker, cleaner way of achieving certain ends—but such speed and efficiency often comes at the cost of legislative resentment, which might cause delays and trouble later. Ultimately, it is comparing the importance of the desired outcome and the hard feelings caused by circumventing legislators.

The question then becomes: do more powerful governors (as measured by Beyle) actually use their power? As the preceding analysis suggests, this is probably best understood on a case-by-case basis, with even the most powerful governor (ironically, West Virginia's governor) comparing the importance of the outcome to the reaction of legislators before making a decision about issuing an order. In the specific case of creating a state-level science and technology council, there are at least three dimensions to an executive order: scope, membership, and authority. It seems reasonable that the more authority a

council has, the more likely it will be created by legislation because the council will need the political support and credibility that comes from joint action by a governor and a legislature, as opposed to just one or the other.

The positive, albeit relatively weak, relationship between gubernatorial power and the adoption of science and technology councils may suggest that these councils have limited authority. In other words, the governor created them but either could not give them substantial authority over policy and budget because of constitutional limitations or chose not to give them substantial authority to avoid angering legislators. In these cases, the councils are more ceremonial and useful as a forum for discussion than for actual policy change.

This relationship may also suggest a greater interest on the part of governors in science and technology issues, with powerful governors taking a more active role in shaping policy in this area. It may also suggest a political vacuum of sorts in this area, with governors noting the absence of policy actors in science and technology and seeking to fill that vacuum with a state council. All of this is promising grounds for further research with a more qualitative focus.

If created and appointed by a governor, the governor's office is also likely to promote news of the council, its members, and its charge as an example of the governor's leadership on an important issue. By promoting this news, perhaps through a press conference or news release, a governor's office increases the likelihood that the news will spread to other governors and their states through overlapping media sources. A similar dynamic occurs if the council is primarily a legislative creation. Legislators who were responsible for the bill will generate news coverage and cite it as an example of their leadership in science and technology. A governor who signs the bill into law is also likely to take some measure of credit for the establishment of such a council, whether or not s/he took an active role in promoting it as it worked its way through the legislative process.

Governors and legislators will also share the news of their actions with regional and national organizations, such as the Southern Growth Policies Board (on a regional level) or the National Governors Association and the National Conference of State Legislatures (at a national level). If the organization is regional in scope, it will serve as a geographically focused conduit through websites, newsletters, and meetings. If the organization is

national, it will serve as a conduit, albeit much more diffuse, for this news by communicating it to a national audience.

Finally, the appointees themselves help to generate a sense of newsworthiness. Often, appointees to such state councils are opinion leaders and enjoy a high profile within a state—as academics, business leaders, state agency executives, and philanthropists. Their profile and credibility are reasons for their appointment. Many of these appointees have access to media offices that spread the news about their participation. In those cases where there is substantial discretion about the appointment process (which is more likely with an executive order than legislation), the very composition of the council makes it a news story. Partisan balance, geographic representation, the participation of underrepresented groups, and potential conflicts of interests among council members all contribute to newsworthiness.

All of this communication can occur on a more informal, idiosyncratic basis, as well. Legislators, business leaders, and academics may know counterparts in other states and share news about the creation of a council as a matter of course. In other words, such communications need not occur in a systematic, deliberate fashion; it may

also occur simply because two people who know each other because they hold similar positions and they exchange news and ideas.

This is even more likely between states where the density of interactions is greater, which can occur when initial relationships between counterparts expand to include colleagues, associates, and staff. For instance, this is the case between Kentucky and West Virginia, where initial contact between EPSCoR directors and university presidents from both states have grown to include regular exchanges of news between staff in these offices.

The absence of one expected relationship on this innovation is particularly interesting. Postsecondary education governance structure did not have a significant effect on state council adoption. If a state has a more centralized postsecondary governance structure, it seems reasonable to expect the people populating that structure would have an interest in a state science and technology council. The direction of this relationship, however, could be either way. A centralized structure, such as a consolidated governing board, might behave in a manner consistent with the "academic cartel" theory as discussed above and support the creation of a council because it is in the interests of campus academic leaders. On the other

hand, a consolidated governing board might perceive a state council as a competitor or a threat to its authority. Obviously, the composition of a council would have a substantial effect on this point.

If appointees to a council are drawn primarily from the ranks of academe and others supportive of campus interests, a centralized structure would logically regard such a council as an ally, or even an extension, of its own efforts to promote science and technology funding and policy change. If, however, a council's members come from outside the "cartel"—which could be part of an effort by a governor or legislature to balance the power of the academic community—then the centralized structure is likely to view the council with suspicion and even hostility.

This latter scenario is perhaps most likely to occur when a governor or legislature perceives research universities to be too focused on basic research, too far removed from the practical economic development implications of research, and/or too slow in responding to the needs of the business community, and so elected officials establish a state council to bring higher education into closer alignment with the governor's or legislature's vision. A council so conceived would presumably include more members from business and economic

development agencies than from academe and higher education executive agencies.

State cooperative technology programs

Figure 11 displays the hazard data for state collaborative technology programs. The first event of this type occurred in 1983, when six states adopted such programs. More than the other two innovations in this study, the adoption of these programs are clustered in particular years. There were eight events in both 1991 and 1993, five events in 1989, and four events in three different years (1984, 1985, and 1987). Again, a very high hazard in 1993 is the result of a large number of events and a smaller risk set.

Figure 11. State Collaborative Technology Programs, 1983-2002

Year	Risk Set	Number of events	Cumulative	Hazard	States
1983	50	7	7	0.14	CO, HI, OH, PA, SC, UT, WI
1984	43	4	11	0.093	DE, MD, VT, VA
1985	39	4	15	0.103	MI, MT, NE, NJ, RI
1986	35	1	16	0.028	AR
1987	34	4	20	0.118	AL, KS, OK, SD
1988	30	1	21	0.033	KY
1989	29	5	26	0.172	CT, ID, IA, TX, WY
1990	24	1	27	0.042	GA
1991	23	8	35	0.348	IL, IN, LA, MN,

					NH, NM, NY, ND
1992	15	2	37	0.133	FL, WA
1993	13	8	45	0.615	CA, ME, MA, MO, NV, OR, TN
1994	5	2	47	0.4	MS, WV
1995	3	0	0	0.000	
1996	3	0	0	0.000	
1997	0	0	0	0.000	
1998	0	0	0	0.000	
1999	0	0	0	0.000	
2000	3	3	50	1.000	AK, AZ, NC

Figure 12 displays the statistical results of EHA for state cooperative technology programs.

Figure 12. Discrete-time EHA of adoption of cooperative technology programs

independent variable	exp(B)	SE
Income	0.999	0.000
Political party control	2.304 *	1.266
Legislative professionalism	0.111	0.171
Gubernatorial power	2.243	0.103
Postsecondary attainment	1.084	0.685
Postsecondary governance	0.946 *	0.143
EPSCoR	0.274	0.145
* significant at the .05 level		

On the third and final policy innovation—the adoption of cooperative technology programs—there were two statistically significant relationships. Building on the “institutional control” hypothesis and clarifying the direction of the relationship, Republican control of the legislature makes a state more likely to adopt cooperative

technology programs. A centralized governance structure makes adoption of this innovation less likely.

Other researchers have found a party control effect in higher education policy; states with Republican-controlled legislatures are more likely to engage in postsecondary policy innovation (McLendon, Heller, and Young, 2006) and more likely to adopt performance funding and performance budgeting policies (McLendon, Hearn, and Deaton, 2006). Intuitively, these relationships make sense. In general, Republicans are more critical of higher education and thus more likely to try to reform higher education through policy and/or budget changes. As a party, Republicans are more closely associated with business than with academe. Republicans have a long tradition of decrying the liberal bias of higher education institutions, faculty, and students. Over the last quarter century, a substantial body of literature has been written by conservatives on this theme, including books with unambiguous and provocative titles such as Profscam: Professors and the Demise of Higher Education, by Charles Sykes, and Impostors in the Temple: The Decline of the American University, by Martin Anderson. More recently, conservative academic groups such as the American Council of Trustees and Alumni

have collaborated with Republican legislators in at least 24 states to introduce the "Academic Bill of Rights."

The relationship between Republican-controlled legislatures and cooperative technology programs may be an example of a more constructive impulse among GOP state lawmakers to change higher education. Cooperative technology programs are designed to build new connections among business, government, and universities to promote applied research and technology transfer. Since Hewlett and Packard, as Stanford University undergraduates, transformed the southern Bay Area of California into an economic powerhouse from their garage workshop in the 1930s and 1940s, policymakers have looked to universities as engines of economic development.

These same policymakers become impatient with university research that does not lead to new patents, products, and royalties, or with universities that are not sufficiently "entrepreneurial" in their thinking. Cooperative technology programs are often promoted by policymakers as essential to harnessing the power of higher education for economic growth. The results of this study suggest that Republican policymakers, in particular, are promoting these programs at the state level.

Contrary to this study's hypothesis that centralized governance structures would make states more likely to adopt all of these innovations, in this case the relationship is the opposite of what was expected. States with centralized governance structures are less likely to adopt cooperative technology programs. This finding, however, may reinforce the "academic cartel" theory as described above. If centralized governance structures do institutionalize the preferences and interests of academic administrators, and these administrators are unenthusiastic about greater collaboration with business as manifested in cooperative technology programs, then the negative relationship makes sense.

Academic administrators and faculty may be unenthusiastic for a number of reasons. They may be concerned about business encroaching on academic freedom. Calls by business and government for more applied research, and in certain fields, may be regarded as unacceptable limitations or intrusions on faculty research agendas. Even if faculty do not think their academic freedom is being violated, they may be reluctant because they do not completely understand the "business world" and prefer not to engage in entrepreneurial activities. And even if there are no concerns about academic freedom and there is

sufficient familiarity and a comfort level with "doing business," some faculty and administrators may still resist cooperative technology programs because they disagree with the terms of the program, such as intellectual property rights, division of royalties, or conflict of interest requirements.

Connection to other studies

This study applied a well-established technique (EHA) to a new policy domain (science and technology policy), so there is little basis for comparison in terms of the explanatory or predictive powers of this study's models to other models. Innovation diffusion studies in other policy domains, such as education policy, regularly fail to find statistically significant relationships between the covariates of interest (the independent variables) and the adoption of particular policy innovations.

In their study, McLendon, Hearn, and Deaton found that one of the policy innovations they examined, performance-reporting policies, was "insensitive to all of the hypothesized influences" (McLendon, Hearn, and Deaton, 2006). They did find, however, that legislative party strength and higher education governance arrangements were "the primary drivers" of state adoption of performance

funding and performance budgeting. Both of these variables exhibited statistically significant impact at least at the .05 level.

In his dissertation, Deaton found a few statistically significant relationships (most at the 0.1 level) between some of the covariates in his model and the policy innovations he studied—tuition centralization and tuition decentralization. Specifically, he found that regional diffusion, higher education governance structure, the existence of a statewide lottery scholarship program, and a Republican-dominated legislature all increased the likelihood of adopting a centralized tuition policy, while governance structure and per capita income were influential in states' decisions to adopt decentralized tuition policies (Deaton, 2006). It is worth noting that one additional factor—existence of a statewide lottery scholarship program—became significant when the spline technique was used to check and account for temporal dependence.

Chapter Six

Conclusions and Implications

With the recent passage of the America COMPETES Act and the "Innovation America" initiative from the National Governors Association, there is more urgency than ever before among states to understand the nature of science and technology innovation. Hopefully, this study will help state policymakers with one piece of that puzzle by examining the effects of demographic, economic, and political factors on states' decisions to adopt science and technology policy innovations.

In many policy areas, states are the fundamental unit of analysis. In the Tenth Amendment to the U.S. Constitution, powers not specifically delegated to the federal government are reserved to the states. Therefore, states have historically taken the lead on a wide range of policy issues. State policy action can take many forms, but the passage of legislation and the issuance of executive orders are the two most obvious and robust examples. Understanding the factors that influence state

policy action is a long-standing concern for political scientists.

Understanding these factors has also become a concern for scholars in a variety of fields, from economics to higher education. It should be a concern for scholars in any field where states play a leading role in setting agendas and enacting policies. This is certainly true in science and technology policy, where states are increasingly taking a leadership role as they recognize that the defining feature of the "new economy" is its reliance on science and technology as engines and tools of economic development.

The primary research question in this study is: What are the effects of demographic, economic, and political characteristics of states on their adoption of science and technology policy innovations? In other words, what are the conditions under which states adopt innovative programs and entities to promote a science and technology agenda? The results of this study offer an initial and intriguing, glimpse of the answer.

Summary of results

For each of the science and technology policy innovations, this study found that there were statistically

significant relationships between states' decisions to adopt these innovations and some of the internal determinants. The following summary is arranged by hypothesis.

Figure 13. Summary of findings by hypothesis

Hypothesis	Findings
Wealth increases likelihood of policy innovation.	No significant relationship was found.
Political party control of the legislature increases likelihood of policy innovation.	Republican control of the legislature increases likelihood of adopting cooperative technology programs.
Legislative professionalism increases likelihood of policy innovation.	No significant relationship was found.
Gubernatorial power increases likelihood of policy innovation.	Gubernatorial power increases likelihood of adopting councils.
EPSCoR status increases likelihood of policy innovation.	EPSCoR status increases the likelihood of adopting strategic plans.
Postsecondary education attainment increases likelihood of policy innovation.	No significant relationship was found.
Centralization of postsecondary governance structures increases likelihood of policy innovation.	Centralization of postsecondary governance structure increases likelihood of adopting strategic plans; decreases likelihood of adopting cooperative technology programs.

This summary illustrates an important point about this study: the discrete nature of the three policy innovations under consideration. The hypotheses for this study did not differentiate among the three innovations; each hypothesis made a "blanket" prediction about the nature of the relationship between the innovations and the covariates of interest. As these results show, however, each innovation

has its own different relationships with the independent variables.

Simply because one of the innovations had a significant relationship with one of the covariates does not mean significant relationships existed between that covariate and the other innovations. For example, political party control is a significant factor in adopting cooperative technology programs but not strategic plans or councils. In future research, separate hypotheses should be developed about each policy innovation and its relationships with the covariates. A "blanket" hypothesis overlooks important distinctions among innovations.

Limitations

In terms of limitations, this study is an original but initial foray into the study of diffusion and innovation in the domain of science and technology policy. As such, it builds a conceptual framework from the existing literature on policy diffusion to explain the effects of internal determinants on science and technology policy innovation. It extends analytical methods that have been used in studies of other postsecondary education policy innovations to a study of science and technology policy innovations.

This is an exploratory piece of research which illuminates certain relationships and effects between standard independent variables in diffusion scholarships with a new set of dependent variables drawn from science and technology policy innovations, while at the same time raising further questions and directions for future research. This study introduces a new independent variable, EPSCoR participation, which may be particularly relevant as a potential influence on states' science and technology policy innovation.

While the inclusion of EPSCoR was intended as an alternative to regional diffusion, regional effects need to be examined in future studies. Some science and research policy issues, by their very nature, compel states to ignore political borders and work as a geographic region. For example, water rights and use policy often affects not only individual states but entire regions. All of the states along rivers such as the Colorado or Columbia grapple with ways to craft effective and innovative water use policies, and proximity is certainly a factor in the policy diffusion process. In some cases, policy innovation in a state upstream of other states may actually dictate innovation in those other states. The same is true for environmental regulatory policy innovations, where

pollution may transcend state borders and require a regional approach to resolve. As the inventory of science and technology policy innovations of interest to researchers expands, regional effects should be considered where geography may be decisive.

Additional covariates of interest

As with almost any event history analysis in the social sciences, there are numerous independent variables, or covariates of interest, that are worth testing but were not included in the explanatory models for various reasons. For this study, one such additional covariate of interest would be the amount of competitive, external research funding in science and technology. What is the effect of large amounts of federal research funding, for example, on a state's innovation adoption behavior? Is there a positive relationship between increased funding and innovation adoption? In some ways, this would be the opposite of EPSCoR status, which is based on small amounts of federal dollars for science research. Funding level is potentially more robust than EPSCoR status, however, because values for every state can be included.

Related to the issue of federal funding is the presence of a national laboratory in a state. There are 21

national labs located across the country, from the Ames Laboratory in Iowa to the Thomas Jefferson National Accelerator Facility in Virginia. These national labs represent a significant investment of federal funds, employ hundreds or even thousands of professionals in scientific and technical fields, and generate substantial research and intellectual property. It is reasonable to hypothesize that the presence of these large labs—especially in smaller states, such as Idaho, New Mexico, and West Virginia—will have an effect on those states' climate for policy innovation. Including the presence of these labs as independent variables in an EHA model is a compelling direction for future research.

A rich source of additional covariates could be culled from reports such as the State New Economy Index from the Kauffman Foundation. This report, and others like it dating back to the mid 1990s, include data on numerous time-varying covariates such as the immigration of knowledge workers among states, number of inventor patents, number of scientists and engineers, and amount of venture capital. Intuitively, these covariates have a more logical and direct relationship with the adoption of science and technology policy innovations than some of the independent variables used in this and other innovation diffusion

studies, such as per capita income or postsecondary education attainment. Further, the State New Economy Index and similar reports only offer a snapshot of the states in a particular year. Subjecting this data to EHA would allow for the development of an explanatory, or predictive, model that could inform and influence state policy decisions in the future.

Additional policy innovations

This study focused on three science and technology policy innovations as the dependent variables—strategic plans, councils, and cooperative technology programs. There are, however, many other policy innovations that are well worth exploring. One of the most interesting is the appointment of a governor's science advisor. Approximately 12 governors currently have science advisors (in a few states, such as Nevada and Wyoming, the advisor's portfolio is focused largely on energy issues). Most of these positions have been created in the last decade. Only one state, New Mexico, has had a science advisor since the 1980s, which makes this innovation consistent in terms of timing of adoption with the other innovations examined in this study.

One major category of policy innovations that were excluded from this study are innovations with fiscal implications. For example, most states have created special tax credits to stimulate research and business growth in science and technology. Many states have also made direct appropriations or grants to universities and nonprofit research institutions in support of science and technology work. For policymakers, innovations with price tags—such as tax credits and budget lines—are generally taken more seriously and debated more thoroughly. In other words, these innovations are likely to be made more deliberately because there is money involved and elected officials are held more accountable for those decisions that have a cost.

An interesting study might be to determine if the adoption behavior for this category of innovation is subject to the same influences as innovations with no (or very little) fiscal implications. One challenge of studying “fiscal” innovations is the difficulty in identifying instances of them within a large state budget. In some cases, appropriations or grants for scientific research are contained with a single line-item for a particular institution, with the understanding between policymakers and administrators that the funding will be

used for this purpose. Tracking these budget items down would be extremely difficult.

In recent years, states have also become interested in establishing research parks as a way to facilitate scientific research and high-tech economic development. These research parks are a reflection of policymakers' understanding about the way research, small business start-ups, and technology transfer occur. In many cases, for example, these parks are located adjacent to a university, building on the assumption that physical proximity is essential for the interactions between academe and industry that leads to new product development and commercialization. Likewise, proximity to a large campus makes it more likely that high-tech companies will have access to an educated workforce (post-doctorates, graduate students, and undergraduates with degrees in technical fields).

A challenge to studying research parks as policy innovations is that many have sprung up without legislation, executive orders, or other official acts by policymakers. In some cases, the only official act in support of a research park might have been a budget increase, and as discussed earlier, tracking instances of these increases is a very daunting task. The definition of

a research park is also elusive. While the concept of a strategic plan, council, or cooperative technology program is fairly consistent across states, the design and configuration of research parks varies substantially from state to state. Arriving at a standard definition for a research park would need to be the first step in a future study of this nature.

Need for a mixed methods approach

As the increased use of EHA in public policy studies over the last 20 years demonstrates, this quantitative approach is a powerful tool for examining the relationships among time, various potentially relevant factors, and the adoption of policy innovations. As with any approach, however, it has its limitations. In the case of public policy, there is an entire set of factors that defy quantification and yet are essential to understanding how policy decisions are made: personalities and personal relationships. And to truly plumb the depths of these factors, a mixed methods design of quantitative and qualitative approaches is necessary.

Policymakers, and elected officials in particular (as distinct from non-elected bureaucrats), base their decisions in part on personal relationships. In some

instances, their decisions are based solely on personal relationships instead of an objective analysis of the facts. Most state legislators are running constantly for re-election, which means most of their time as legislators is spent on direct constituent services and "meeting and greeting" with voters. What time they do have for reading, reviewing, and discussing the substance of issues is overwhelmed by the quantity and variety of issues they must address, which means legislators can only spend a very small fraction of their time on each issue.

Among these numerous issues, elected officials perform a triage of sorts based on the salience of the issues, so that issues with less salience (unfortunately, science and technology often falls into this category) receive correspondingly less time and attention. And while science and technology issues are generally more complex and thus require more time, not less, to grasp fundamental but technical concepts, there is a lack of knowledgeable staff who can distill these complexities into an effective brief for legislators. As a result of all of these factors, legislators look for quick ways to sort through science and technology issues.

One of the quickest ways is for legislators to rely on people with whom they have strong, trusted relationships to

advise them regarding these issues. These people may or may not be scientists and/or technical experts. Given that scientists and politicians seldom run in the same social circles and that scientists are not typically big campaign contributors, it is in fact unlikely that many scientists are in a position to be trusted political confidants. So a part-time, under-staffed state legislator for whom science and technology are not politically salient issues makes decisions and votes about science and technology on the input of friends and confidants who are not scientists or technologists.

This explanation is based on personal observation and experience, but should be examined systematically using a qualitative research design. Semi-structured interviews with policymakers would allow a researcher to probe unquantifiable variables, such as personal relationships, that simple observation and intuition suggest are significant factors. An interview would enhance the quantitative findings by allowing a researcher to ask about the relative effects of different variables—such as gubernatorial power or centralized postsecondary governance structure—on science and technology policy decisions. If a regression shows gubernatorial power is positively related to the adoption of science and technology councils, one

obvious next step is to sit down and ask powerful governors about this relationship and how they have wielded their authority related to science and technology.

Further exploring the "academic cartel" theory

The analysis section of this study makes numerous references to the "academic cartel" theory put forth by McLendon, Hearn, and Deaton (2006). Specifically, this theory might help to explain why states with more centralized postsecondary governance structures are more likely to adopt science and technology strategic plans and less likely to adopt cooperative technology programs. It is difficult to imagine an independent variable that would provide a better test of this "academic cartel" theory than postsecondary governance structure.

A state's governance structure is the most obvious manifestation of authority and control within a postsecondary education system. McLendon, Hearn, and Deaton contend that more centralized governance structures "tend to institutionalize the preferences of faculty and administrators." Presumably, this is because centralized structures are more often populated by "traditional" academic types—i.e., faculty and administrators. Historically, many state higher education executive

officers (SHEEOs) have risen through the ranks of university administration, often serving as a campus executive before taking the helm of an entire system. Florida's former SHEEO, Mark Rosenberg, had previously served as provost at Florida International University. Thomas Meredith led state systems in Alabama and Georgia and served as a university president in Kentucky before returning to Mississippi, where he had been an Executive Vice President at the University of Mississippi earlier in his career, as its SHEEO.

The path to becoming a SHEEO, however, is changing. In some states, the SHEEO position has become a political appointment. For example, Ohio Governor Ted Strickland recently reorganized postsecondary governance in Ohio and appointed Eric Fingerhut, a former U.S. Congressman and Ohio State Senator, as the new Chancellor of the Ohio Board of Regents. As part of this reorganization, the Chancellor will now be a member of Governor Strickland's Cabinet. Another example of a "political" SHEEO is David Skaggs, Executive Director of the Colorado Department of Higher Education. Prior to becoming a SHEEO, Skaggs was a state legislator and member of Congress from Colorado. Prominent businesspeople are also now serving as SHEEOs; Nevada'

recent chancellor was James Rogers, a media magnate and lawyer.

As more SHEEOs are selected from outside academe and assume some measure of power over higher education policy, the "academic cartel" theory may lose some of its explanatory power. In fact, these recent departures from the "traditional" SHEEO profile may signal frustration on the part of state officials with an entrenched "academic cartel" in the state's governance structure. It is not that governors resist a centralized governance structure; rather, they are appointing their own people to lead these centralized structures and thus exercise greater control. If so, this new breed of SHEEO has been hired to break up the cartel and bring more political accountability and business practices to the management of higher education.

The implications of this change for the findings of this study are substantial. As "academic cartels" are replaced by businesspeople and political appointees within postsecondary governance structures, states with centralized structures may become less likely to adopt strategic plans and more likely to adopt cooperative technology programs. Indeed, a whole array of policy innovations—in postsecondary education as well as science and technology—may emerge that reflect the changing nature

of the way universities and colleges are governed. This is an interesting direction for future research.

After policy adoption and innovation

Most policy diffusion studies that have been conducted in education and the social sciences (this study included) do not provide much, if any, information about what happens *after* a particular policy innovation has been adopted. The focus is on the effects of various factors on the decision to adopt (or not adopt) an innovation, but what happens once an innovation is adopted? In this study, for example, there were six states that adopted science and technology strategic plans in 1992. What effect did the adoption of strategic plans have in those states? One of the stated hopes for this study is that it would inform policymakers about the process of policy diffusion and innovation in science and technology, and the results and subsequent analysis have taken a significant step toward that goal. But this study does not answer the question that surely every policymaker will ask: did the innovations make any difference?

Of course, the answer to this question could go in either direction. Because the word "innovation" has a generally positive connotation, the presumption is that

adopting these policy innovations will create more favorable conditions for science and technology in states. A state council can raise the profile of science and technology issues to an indifferent general public and attract the attention of elected officials. A strategic plan can present a well-reasoned, unified agenda for action that results in effective investments of scarce resources that generate a positive return. A cooperative technology program might lead to the next Hewlett Packard or Microsoft.

But what if a state science and technology council, once established, becomes hopelessly embroiled in controversy over stem cell research and prompts a public backlash against science and technology? What if a state's strategic plan makes recommendations for policy and budget actions that ultimately do not bear fruit? What if state funding for a cooperative technology program supplants and dries up private investment? These hypothetical scenarios suggest that there is at least the potential for negative consequences. Without extending this study to include consideration of the effects of these innovations, these questions can not be answered. But answers do exist, and to be most useful to policymakers these questions must be asked and answered.

Conclusion

Justice Brandeis' metaphor of the states as laboratories is particularly apt for this discussion about the diffusion of science and technology policy innovations. In the figurative sense, states are laboratories for public policy. State governments experiment with new ideas, or with variations on existing ideas, and create public policies through the enactment of legislation, the issuance of executive orders, the enforcement of regulations, and the implementation of budgets. State governments then watch to see what happens as a result of these policies and, hopefully, continue their experimentation to make even better and more efficient policies for the public good.

Brandeis' metaphor works in the literal sense, as well. When governors and legislators adopt science and technology policy innovations, they affect the work of scientists and researchers in actual laboratories in their states. In most cases, these effects are not direct or immediate. A science and technology strategic plan, however, can ultimately lead to new funding or reallocation of funds in support of new research agendas. A science and technology council can increase public and political awareness of emerging areas of scientific study. A cooperative technology program can prompt new relationships

between universities and industries. In this sense, experimentation in policy impacts experimentation in physics and medicine, and the laboratories of democracy shape the laboratories of biology and chemistry.

Few, if any, would claim that public policy is characterized by the same level of rational and rigorous design that is the hallmark of scientific experimentation. The policy process is often irrational, idiosyncratic, and difficult to replicate across issues or states. This is all the more reason to use methods and designs from the social sciences to try to understand the policy process and, more specifically, the dynamics of policy diffusion. Governors and legislators, like their scientific and technical counterparts, can look to and learn from each other's experiments, triumphs, and setbacks in the policy arena. This study is a first step in that direction, toward a destination where every state, not just a single courageous one, can be innovative.

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