Do Federal Academic Research and Development Subsidies Crowd out State Funding of Academic Research?

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Abstract

(To be added)

Key words: Federal subsidy, higher education, research and development,

Introduction

In the U.S., the federal government is the primary supporter of academic research and development (R&D). However, state governments have increased their financial support for academic research since the early 1990s in pursuit of technology-based economic development. The involvement of both federal and state governments in funding academic R&D reveals an important facet of fiscal federalism in science and technology policy.

This empirical study is intended to examine the relationship between the funding of public academic R&D from federal and state governments. The basic descriptive statistics show that the total federally financed and state financed R&D expenditures by public doctorate-granting universities grew by 263 and 208 percent from 1980 to 2009, respectively.[1] Because federal funding has been growing more rapidly than state funding of public university R&D, the average state share of total government financed public university R&D expenditures has been declining since 1980 (see Table 1 for details). The data seem to imply that federal funding of public academic R&D may have crowded out some state financial support for R&D activities at higher education institutions.

(Insert Table 1 about here)

We further examine data on the annual growth of state public universities' R&D expenditures financed by federal and state governments from 1979 through 2007. Our empirical analysis employs the panel study econometric techniques to explore the effect of federal grant funding on state funding of public university R&D. The model is applied

[1] In FY1980, federal and state governments financed about $4.92 and $0.93 billion (in 2005 constant dollars) of public doctorate-granting university R&D expenditures. In FY2009, federal and state financed public doctorate-granting university R&D expenditures grew to $17.88 and $2.85 billion (in 2005 constant dollars).

to all fifty states from 1979 through 2007. The statistical estimates indicate that there is a significant crowd-out effect between federal and state funding of R&D at public higher education institutions.

This empirical study suggests that it is not effective to boost total financial resources for academic research by simply increasing growth rate of federal funding. Federal government must become more innovative in the design and implementation of federal research grants to maintain or even enhance states' efforts is this important area.

Review of empirical literature

There is a large body of empirical literature on estimating the effect of various intergovernmental grants to state and local governments. The majority of empirical studies suggest that intergovernmental grants rarely stimulate additional spending from recipients' own sources on targeted programs. For instance, in an early review by Hines and Thaler (1995), eight of the ten most cited empirical studies reported that a $1 grant increases the spending of recipient jurisdictions by less than $1 (as low as 25 cents), which shows that intergovernmental grants very likely crowd out state and local expenditures that would have been made without the grants. This crowd-out effect is consistent with economic theory. Many economic studies have found that demand for government services is generally price- and income-inelastic (Fisher, 2007). Therefore, a price effect (from a match grant) or an income effect (from a non-matching grant) will not be large enough to increase the demand by the amount of the grant. As a result, a fraction of the grant is diverted to support other government programs or to reduce tax.

Bradford and Oates (1971) developed a political economy model predicting that federal grants crowd out state government spending, leading to little or no increase in combined public spending. The crowd-out effect of federal aid on state funding exists in many federal grant programs. Following is a summary of literature on three specific federal grant programs: Title 1; alcohol, drug abuse, and mental health block grants; and highway aid.[2]

Federal involvement in education finance has been quite modest compared to state and local expenditures. Most of the federal grants for education have been categorical grants targeted for specialized education programs. The largest federal education grant program is Title I, which has provided compensatory education to children from low-income families since 1965.[3] The study by Feldstein (1978) on Title 1 analyzed the total education expenditures of 4,690 school districts across the country in 1970. His study reported that, for every additional dollar of Title 1 federal aid, a school district increases its total educational expenditures by 72 cents. Using annual financial data at the school district level from 1991 to 1995, Gordon (2004) estimated the effect of a change in the grant amount on the change in targeted expenditure at the state or local level. The article found that Title I grants initially boost total school district revenue and instructional spending about dollar for dollar. However, by the third year following Title I changes, the effects are no longer significantly positive because local government reactions counter the effects of Title I.

[2] The crowd-out effect is also reported in studies of other federal grants. For instance, Craig and Inman (1986) reported that a dollar of federal lump-sum welfare aid increases state welfare spending by only 7.6 cents. Fisher and Papke (2000) summarized that the estimates of the impact of federal education grants on local spending range from 20 to 90 cents per grant dollar.

[3] There are some federal requirements on how the Title I funds should be used, but the schools receiving the funds still have a fair amount of latitude in how to spend the money to improve academic performance of at-risk children.

Another federal grant program is the alcohol, drug abuse, and mental health (ADAMH) block grant. This federal grant was created in 1981 to support state programs to address issues of alcoholism, drug abuse, and mental health. Being concerned with the possible substitution effect, the federal government has imposed restrictions requiring that states maintain their spending effort from their own funds. A study by Jacobsen and McGuire (1996) suggested that federal ADA grants were used by states almost entirely as a substitute for states' own funding of substance abuse prevention and treatment services before 1990. However, they found that the federal ADA grant had a strong positive effect on states' own spending on substance abuse programs after 1990, when the federal government stepped up its efforts to enforce the requirements of state funding levels. A later study by Gamkhar and Sim (2001) reported no statistically significant effects of the current year ADA grant on state and local substance abuse expenditures, even after 1990. However, they found that the one period lagged ADA grant had a large effect on state and local government spending throughout the period of 1985–1995; on the margin, a dollar increase in ADA block grant generates an additional 80 cents in total state and local government spending.

Federal highway aid is probably the largest federal grant program to the states, providing billions of dollars to support state highway construction and maintenance. Federal highway grants are made through the Federal Highway Trust Fund financed by a federal tax on gasoline sales. By using a panel data set for 45 states in the U.S. for the years 1976–1990, Gamkhar (2000) showed that when federal highway aid increases for three consecutive years, every $1 increase in federal highway grant obligations leads to an 87 cent increase in the highway expenditures of state and local governments.

After controlling for endogeneity of federal grants, Knight (2002) reported that the impact of a dollar of federal highway grants on state highway spending varies from 12 to 33 cents. Knight's findings indicate that federal grants do crowd out state spending in an economically and statistically significant manner, leading to little increase in net spending on highway programs. The instrumental variables he used to address the political endogeneity of grants include the U.S. House and Senate transportation committees, majority party, and membership tenure. In a more recent study, Gamkhar (2003) estimated the effect of a dollar of federal highway grants at 37 cents. The recent, endogeneity-corrected studies on federal highway aid clearly suggest that it is rare to find places where federal grant money does not crowd out state spending on highway programs.

An empirical study closely related to this research is Connolly (1997) that investigates the relationship between internal and external funding of academic research.[4] By estimating a vector autoregression using a panel of 195 research-oriented universities over the period 1979-1990, the results suggest that external funding has a positive effect on future levels of internal support. In other words, the evidence refutes the hypothesis that institutional funds are crowded out by external support. Our research is intended to examine the relationship between two major external funding sources—academic R&D expenditures financed by federal and state governments. We hypothesize that federal funding of academic research may crowd out state support as consistent with crowd-out effects in other funding areas.

[4] According to the author's definition, "external funding" must originate from a source outside of the university, such as a governmental agency, a private firm or a nonprofit foundation whereas "internal funding" must come from funds that can be used in any way the university chooses.

Funding of academic research

In the United States, university scientists have been the primary performers of science and engineering research since WWII. Academic research has been supported by funds from several sources, with the federal government being the primary sponsor. In fiscal year 2009, all doctorate-granting higher education institutions in the U.S. spent a total of $54 billon on R&D activities, $32 billion (about 60 percent) from federal agencies and $3.6 billion (7 percent) from state government.[5] Public doctorate-granting universities received $19.8 and $3.2 billion of their R&D expenditures from federal and state governments in 2009, respectively. Slightly less than 90 percent (or 89 percent, to be specific) of state financed academic R&D expenditures were spent by public universities.

Both federal and state governments support academic R&D, and the federal government plays a dominant role by providing a large share of financial support for university research. Federal dominance in this area is a result of federal investment since shortly after WWII. Vannevar Bush recommended that the federal government take the lead in "promoting the flow of new scientific knowledge and the development of scientific talent" (Bush, 1945, p. 4). The involvement of state governments came later, as state governments intensified their efforts to assert a greater role in the formulation and administration of national science and technology policies beginning in the early 1980s (Feller, 1997).

Federal dominance in supporting academic research is coupled with uneven distribution of federal funding across states. Table 2 presents the percent share of federal government financed academic R&D expenditures of individual states for some selected

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[5] In the NSF's *Survey of Research and Development Expenditures at Universities and Colleges*, doctorate-granting institutions include all research I, research II, doctoral I and doctoral II universities and a few other doctorate-granting universities after 1979.

years. The data suggest a substantial variation in state's share of federally financed academic R&D expenditure. The top ten states (California, New York, Maryland, Texas, Pennsylvania, Massachusetts, Illinois, North Carolina, Ohio and Michigan) received more than three percent of federal support to academic research. The shares of the ten states at the bottom (Arkansas, Alaska, West Virginia, Delaware, Vermont, North Dakota, Idaho, Maine, South Dakota and Wyoming) are at or below 0.35 percent. Such large disparities reflect tremendous gaps in academic research capacity that is critical to the merit-based competition for federal research grants.

(Insert Table 2 about here)

The involvement of both federal and state governments in funding academic research provides an opportunity to study the dynamic relationship between the two funding sources. One important question is whether the federal funding crowds out state funding of scientific research conducted by university scientists. The presence of crowd-out effects may compromise the policy goal of federal funding agencies to increase financial support in targeted research areas. Moreover, the increase in total funding by less than the federal grant amount may lead to under-investment in some critical scientific research areas in the states. Therefore, it is important to explore if a crowd-out effect exists and to estimate the magnitude of the effect if it does.

As a first step, we examine the annual growth of both federal funding and state funding of public university research in the period 1979–2009. We use data from the NSF's *Survey of Research and Development Expenditures at Universities and Colleges*. This period witnessed increases in federal funding of public academic R&D in 1,126 state-years and drops in only 374 state-years. Compared with the prior years, state governments increased their funding of public academic research in 888 state-years and cut their funding in 612 state-years. The overall trend is that both federal and state governments generally boosted their spending on university R&D activities. This is primarily driven by nationwide recognition of the important role of research and development in economic development that began in the early 1980s.

Despite the overall consensus of pro-R&D in this period, the federal and state actions with regard to academic research funding did not always resonate. The overall growth of the public university R&D expenditures financed by the two levels of government does not mean that the federal and state governments take synchronized actions to support university research. On the contrary, a detailed examination of data turns out that state governments cut growth of their funding in slightly below half of all the years when the federal government increased the growth of federal research funding to public universities. It is also noteworthy that state governments increased their growth of funding in slightly over half of all the years when the federal government reduced the growth of its support of academic research. Such a "countercyclical" pattern of state actions reveals an important characteristic of state level decision-making with regard to supporting research activities in public universities.

We also examine the annual growth of academic R&D expenditures of the top ten states in receipt of federal R&D funding. Figure 1 shows the lines graphs of annual growth of academic R&D expenditures financed by federal and state sources for each of the states. Table 3 presents the number of years during 1980-2009 for each of the four combinations of federal and state accelerated or decelerated growth of spending on academic R&D. A similar "countercyclical" applies to the states as well. In the state of

California, the growth rates of both federally and state financed academic R&D expenditures increased in seven years (1984, 1985, 1986, 1996, 2000, 2002 and 2008), decreased in five years (1982, 1989, 1993, 2001 and 2004). However, the paces of growth of support from federal and state government headed to opposite directions in 17 out of 29 years—this period saw accelerated growth of federal support but decelerated state support in eight years (1983, 1987, 1988, 1992, 1995, 1998, 2003 and 2009), decelerated federal support but accelerated state support in nine years (1981, 1990, 1991, 1994, 1997, 1999, 2005, 2006 and 2007). The other states follow similar patterns as demonstrated in Figure 1 and Table 3. The preliminary evidence indicates substitute nature of state funding of academic research with regard to federal support.

(Insert Figure 1 about here)

(Insert Table 3 about here)

Empirical model and data

This empirical study examines how the funding of public academic R&D from the federal government may affect state funding of public academic R&D. The research question is whether federal funding of public academic R&D crowds out state financial support to R&D activities of higher education institutions. The empirical model is set up as follows:

$$AS_{i,t} = \beta_0 + \beta_1 AF_{i,t} + \beta_2 SI_{i,t} + \beta_3 SE_{i,t} + \varepsilon_{i,t}$$

The dependent variable *AS* is the annual growth of a state's own financed public academic R&D expenditures in a specific year. The key independent variable *AF* is the annual growth of a state's federally financed public academic R&D expenditures. Other independent variables include the annual growth of each state's personal income, and the annual growth of each state's expenditures on higher education.

State's personal income and state's expenditures on higher education are used to represent state preferences for public academic research. Voters' demand for university research is inevitably affected by the level of wealth in the state. A wealthier state is likely to invest more state resources in public academic research than a poorer state. In addition, a state's taste for public academic research is closely related to its preference for investing in higher education. If a state highly values the contributions of higher education, it is likely to support a larger budget appropriation for the higher education sector as a whole, and also to better exploit the research talents in its universities by funding more academic R&D activities.

The state's annual federally financed public academic R&D expenditures are the total federal grants all public universities in a state expend in a given year. This study is intended to explore the relationship between federal grant funding and the state funding of public academic R&D at the state level. One potential issue is that the federal grant funding may be partially endogenous because both federal and state government budgets are determined through a political process. A state's receipt of federal grants for public academic R&D may reflect underlying constituent preferences within a state through their elected representatives at the federal level. The same voters' preferences also likely affect state spending on public academic research. In other words, if voters in some state highly value the contribution of R&D in general and university research in particular, they are likely to demand more state budget appropriations on academic research programs and also to acquire additional federal funding through the influence of their representatives in Congress.

It should be noted, however, that the political influence on the distribution of federal academic R&D funding is limited. Unlike other federal grants such as federal highway grants that are distributed primarily according to formulas, the federal grants for university research are made primarily through merit-based competition. All research proposals are reviewed according to some commonly accepted intellectual merit criteria, and only those ranked highly on those criteria get funded. Therefore, the share of federal grant funding a state receives largely depends on how competitive its university scientists are. This is basically a capacity-based distribution. In addition to research capacity, the distribution of a small proportion of federal R&D funds – academic earmarks – is affected by political factors because state representatives to Congress may secure earmarked funding to support research centers or projects in their higher education institutions.

As Savage observed, the House and Senate appropriations committees play a decisive role in federal earmarked spending on academic research (Savage, 1999). Since the early 1980s, it has become common for members of the appropriations committees to bring academic earmarks back to their congressional districts or states (Savage, 1999).[6] Although academic earmarks represent a small fraction of total federal academic R&D funding, it has become an attractive alternative source of funding for universities. The building of research capacity takes a fairly long time. However, university lobbying efforts could bring a quicker return—federal funding earmarked for specific research

[6] Academic earmarks totaled less than $17 million in 1980 and rose to about $17 billion in 2001, representing about 10 percent of total federal funding of academic research (De Figueiredo and Silverman, 2002).

programs for some targeted state universities. The magnitude of total academic earmarks is small, but it likely accounts for a large share of annual change in federal grants a state may receive. So the state's federally financed public academic R&D variable is still partially endogenous, which creates a major challenge to empirical estimation of the crowd-out effect.

To address the issue of endogenous federally financed public academic R&D expenditures, we use the annual growth of federally financed public academic R&D expenditures to explore its impact on the annual growth of state financed public academic R&D expenditures. The use of growth rate instead of total amount of federal funding of academic research may help to ease the concern with the potentially endogenous federal funding variable. Voters' preferences and university lobbying efforts may very little from year to year so that the differenced model helps to minimize the effects on the growth of either federally or state financed public academic R&D expenditures.

The data on each state's own financed and federally financed public academic R&D expenditures are obtained from the NSF's *Survey of Research and Development Expenditures at Universities and Colleges*.[7] The survey has been collecting data since 1972 on separately budgeted R&D expenditures within academic institutions by source of funds, including federal and state governments. Separate expenditure data are available by state, control (public or private), highest degree granted (doctorate, master's, or bachelor's degree-granting institutions), Carnegie classification as well as academic field (NSF, Division of Science Resources Statistics, 2007).[8] The data are collected from

[7] Retrieved on July 21, 2011 from https://webcaspar.nsf.gov/

[8] Before FY1998, a census of eligible institutions was conducted once every 5 years; during intervening years, eligible institutions were sampled. Since 1998, a census of all eligible institutions has been conducted annually (NSF, Division of Science Resources Statistics, 2007).

universities directly, using consistent, uniform definitions and collection techniques.[9] In this paper, we focus on public doctorate-granting institutions because the doctorate-granting institutions account for most of the academic R&D expenditures, and public universities receive most of state funding for academic research.[10] Another advantage is that the data reported by these institutions are consistent over the years and across institutions. Almost all of the doctorate-granting institutions reported data to the survey every year. In addition, most of these major R&D-performing institutions have incorporated the data that are needed to complete this survey into their record-keeping systems, thereby ensuring a consistent format from one year to the next (NSF, Division of Science Resources Statistics, 2007).

The variables of state's annual personal income and expenditures on higher education are also measured in annual growth rates. The data on each state's annual personal income are from the *Regional Economic Accounts*, Bureau of Economic Analysis, U.S. Department of Commerce.[11] The data on each state's annual expenditures on higher education are from the *State and Local Government Finances*, U.S. Census Bureau.[12]

The state's annual own financed public academic R&D expenditures, and state's annual federally financed public academic R&D expenditures are converted into constant dollars using GDP implicit price deflators (with base year of 2005) before the annual growth rates are calculated. The data on state's annual personal income and state's annual expenditures on higher education are also converted using BEA's GDP implicit

[9] In FY1978, the survey covered a different population and used different questions than preceding or subsequent surveys and is therefore not comparable to other years (NSF, Division of Science Resources Statistics, 2007).

[10] Responses were received from 98.6% of all doctorate-granting institutions, to which 98.5% of the estimated national R&D expenditures in S&E fields had been disbursed in the 2006 survey (NSF, Division of Science Resources Statistics, 2007).

[11] Retrieved on July 21, 2011 from http://www.bea.gov/iTable/index_regional.cfm

[12] Retrieved on July 21, 2011 from http://www.census.gov/govs/estimate/

price deflators with the base year 2005. Table 4 presents some descriptive statistics of the variables.

(Insert Table 4 about here)

Result and discussion

We implement the empirical estimation on a panel data set including all 50 states over the period from 1979 to 2007. The total number of observations is 1,400. We first run panel estimation with state fixed effects, which are used to control for time-invariant factors within each state that may affect the annual growth of state's own financed public academic R&D expenditures. Next we add a time trend variable for each state to further control for persistent time trend in supporting university research in some states. Finally we include time fixed effects in addition to state fixed effects and state trend variables to account for nationwide factors that may have affected all 50 states. The statistical results are presented in Table 5.

(Insert Table 5 about here)

As discussed in the prior section, the federal funding of academic R&D may be partially endogenous and we believe a differenced model can help to minimize the potential bias that may exist in the estimates. We examine the presence of endogeneity using two-stage least squares (2SLS) estimations, regressing the annual growth of federally financed public academic R&D expenditures in a state on some selected instrument variables in the first stage, and then use the estimated federally financed public academic R&D expenditures in the second stage of the estimation. We select two instrument variables: the annual growth of federal funds for federal intramural R&D, and the annual growth of the number of state's doctoral recipients in science-related disciplines at public universities in a state. The selection of instrument variables is based on the criterion that they affect federal sponsored academic R&D funding, but they do not directly affect state spending on university research. The number of doctoral recipients in science-related disciplines is a key indicator of research capacity of universities in a particular state. The federal funds for federal intramural R&D is also closely related to the research capacity because of the likely close ties between university scientists and researchers working in a federal laboratory in the state. The growth of a state's research capacity determines the change of federal R&D funding it may secure through largely merit-based competition whereas its impact on politics-driven state budgetary decisions is minimum. As we expect, all the Hausman test statistics are not significant suggesting that there is no systematic difference between the regular fixed effect regression estimates and the 2SLS estimates. This basically confirms our expectation that the differenced model with growth measures is an effective way to address the partial endogeneity issue.

The statistical results indicate that there may exist a substitutary relationship between state and federally financed public academic R&D expenditures. This finding is consistent with preliminary descriptive evidence we demonstrate with the line graphs. The estimated coefficient of the key explanatory variable – annual growth of state's federally financed public academic R&D expenditures is consistently negative and statistically significant across the three specifications of the model. The estimates range from -0.47 to -0.69. If a state's spending of federal R&D dollars rises by ten percentage points, the state government cuts its own support of public academic R&D expenditures by about 5~7 percentage points, everything else being equal.

The mean values of the annual growth of state and federally financed public academic R&D expenditures in this period (1979-2007) are 9.8 and 5.5 percent, respectively. If the federal government raises its growth rate by ten percentage points to 15.5 percent next year, the state will cut the growth rate of state support by 5~7 percentage points to 2.8~4.8 percent. The universities will receive increased funding from both the federal and state government. However, the states can hold back their contribution when their universities can secure larger growth of federal R&D dollars. On the other hand, if the federal government cuts its growth rate by ten percentage points to 0.5 percent next year, the state will increase their growth rate to 12.3~13.3 percent.

We may use the mean values of the annual federally and state financed public academic R&D expenditures during 1979-2006—$187 and 34 million to estimate the effects of changing federal funding of academic research. If the federal government raises its funding by $29 million (15.5 percent growth) next year, the state will only increase their funding by $1-1.6 million (2.8~4.8 percent growth). On the other hand, when the federal government increases its funding by a moderate amount of $1 million (0.5 percent growth) next year, the state will substantially increase their funding by $4~4.5 million (12.3~13.3 percent growth).

According to economic theory, a state with higher personal income is likely to spend more on public services, including university research that is often deemed important to technology-driven economic growth. In addition, we expect proportionate changes in state's annual spending on higher education and state's own financed public academic R&D expenditures because university research is one of the primary functions of public doctorate-granting universities. The statistical results show the effects of the annual growth of state's personal income and the annual growth of state's spending on higher education to be in the right direction. However, the estimates are not statistically significant. In other words, we cannot conclude that the growth of state's own financed public academic R&D expenditures keeps pace with the growth of personal income or state spending on higher education institutions. It should be noted that the insignificant estimates do not exclude a significant positive relationship between state's own financed public academic R&D expenditures and state's personal income or spending on higher education in dollar amounts.

We have some preliminary evidence that the federally financed public academic R&D expenditures may crowd out state spending on university R&D in the sense that state governments may cut their growth of support to university R&D once the federal government augments the growth of its funding of academic research. We expect the crowd-out effects to exist because state money is always fungible and there are always different programs competing for state funds. Like most of other public programs, the demand for academic research is likely inelastic to changes in income. So it is probable that after receiving or anticipating the receipt of federal funds, state government likely diverts part of what they would have intended to spend on public academic R&D to other budgetary categories. The crowd-out effects take place because state politicians may have other more important programs to fund. To some state-level policy makers, academic R&D is often not at the top of their agendas. Even though some states believe that university research plays an important role in technological innovation, business expansion, and economic prosperity, they may still believe that it is primarily a federal responsibility to support university research projects, and they do not need to invest too much in this area. This may partially explain why some states spend their money to build necessary capacity for acquiring federal funds. Once federal funds come, state funds will likely disappear or at least decline gradually over time.

Conclusion

(To be added)

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Table 1: The trend of states' public academic R&D expenditures financed by federal and state governments

		1980	1985	1990	1995	2000	2005	2009
Federal share of total government financed public academic R&D expenditures	Mean	80.26	79.48	79.77	81.50	82.63	86.47	86.37
	Median	83.05	83.38	83.17	84.82	82.28	86.48	88.92
State share of total government financed public academic R&D expenditures	Mean	19.74	20.52	20.23	18.50	17.37	13.53	13.63
	Median	16.95	16.62	16.83	15.18	17.72	13.52	11.08

Note: The descriptive statistics only cover federally or state own financed R&D expenditures by state public doctorate-granting universities.

Table 2: State share of federal government financed academic R&D expenditures by state—Doctoral granting institutions (selected years)

State	1975	1980	1985	1990	1995	2000	2005
Alabama	1.19	0.97	1.09	1.44	1.53	1.62	1.57
Alaska	0.54	0.66	0.30	0.34	0.29	0.28	0.32
Arizona	0.78	1.04	1.10	1.30	1.62	1.44	1.41
Arkansas	0.21	0.18	0.20	0.19	0.26	0.32	0.35
California	16.04	14.87	14.77	14.59	13.80	13.42	13.50
Colorado	2.30	2.29	1.89	1.91	2.03	2.48	2.21
Connecticut	2.01	2.30	2.35	2.02	1.76	1.78	1.66
Delaware	0.16	0.23	0.18	0.20	0.22	0.24	0.28
Florida	2.15	1.77	1.81	2.37	2.45	2.36	2.72
Georgia	1.48	1.79	1.97	2.32	2.37	2.40	2.57
Hawaii	0.70	0.64	0.59	0.45	0.34	0.56	0.67
Idaho	0.22	0.17	0.23	0.15	0.16	0.17	0.24
Illinois	4.75	4.20	4.04	3.74	3.57	3.94	3.93
Indiana	1.97	1.71	1.63	1.43	1.53	1.34	1.33
Iowa	1.11	1.26	1.08	1.20	1.25	1.18	1.11
Kansas	0.75	0.64	0.52	0.46	0.54	0.62	0.63
Kentucky	0.47	0.43	0.32	0.41	0.46	0.54	0.74
Louisiana	0.75	0.72	0.75	0.91	1.04	0.97	0.89
Maine	0.18	0.15	0.18	0.10	0.12	0.14	0.14
Maryland	3.08	7.04	7.45	7.75	7.04	6.38	6.19
Massachusetts	7.85	7.69	7.81	6.90	6.38	6.19	5.69
Michigan	3.52	3.19	2.95	2.93	3.25	3.23	3.08
Minnesota	1.88	1.71	1.48	1.53	1.50	1.35	1.12
Mississippi	0.39	0.37	0.35	0.46	0.48	0.63	0.76
Missouri	2.14	1.77	1.56	1.62	1.64	2.16	2.08
Montana	0.21	0.20	0.15	0.13	0.21	0.29	0.38
Nebraska	0.40	0.43	0.42	0.36	0.43	0.39	0.50
Nevada	0.13	0.17	0.24	0.36	0.37	0.35	0.44
New Hampshire	0.35	0.37	0.44	0.47	0.46	0.56	0.71
New Jersey	1.45	1.28	1.29	1.44	1.60	1.51	1.61
New Mexico	0.79	1.14	1.15	0.91	1.21	0.97	0.89
New York	12.15	10.30	10.76	9.76	8.69	8.55	8.35
North Carolina	2.81	2.34	2.71	3.03	3.48	3.42	3.52
North Dakota	0.20	0.17	0.20	0.22	0.21	0.17	0.27
Ohio	2.70	2.94	2.71	2.76	2.89	2.90	3.12
Oklahoma	0.50	0.60	0.51	0.39	0.46	0.53	0.47
Oregon	1.16	1.11	1.15	1.14	1.22	1.44	1.37
Pennsylvania	4.84	4.88	5.09	5.47	5.82	6.02	5.82
Rhode Island	0.61	0.73	0.73	0.61	0.55	0.52	0.47
South Carolina	0.33	0.44	0.50	0.49	0.84	0.73	0.81
South Dakota	0.13	0.12	0.04	0.07	0.08	0.08	0.14
Tennessee	1.29	1.16	1.18	1.49	1.48	1.38	1.64
Texas	4.81	5.34	5.61	5.61	5.89	6.39	6.14
Utah	1.36	1.20	1.19	1.34	1.08	1.13	0.98
Vermont	0.32	0.29	0.32	0.32	0.25	0.23	0.28
Virginia	1.25	1.51	1.68	1.86	2.04	1.84	1.98
Washington	2.66	2.62	2.63	2.44	2.62	2.57	2.41
West Virginia	0.25	0.23	0.21	0.24	0.23	0.20	0.29
Wisconsin	2.44	2.51	2.37	2.22	2.09	2.02	2.12
Wyoming	0.23	0.16	0.13	0.13	0.12	0.10	0.10

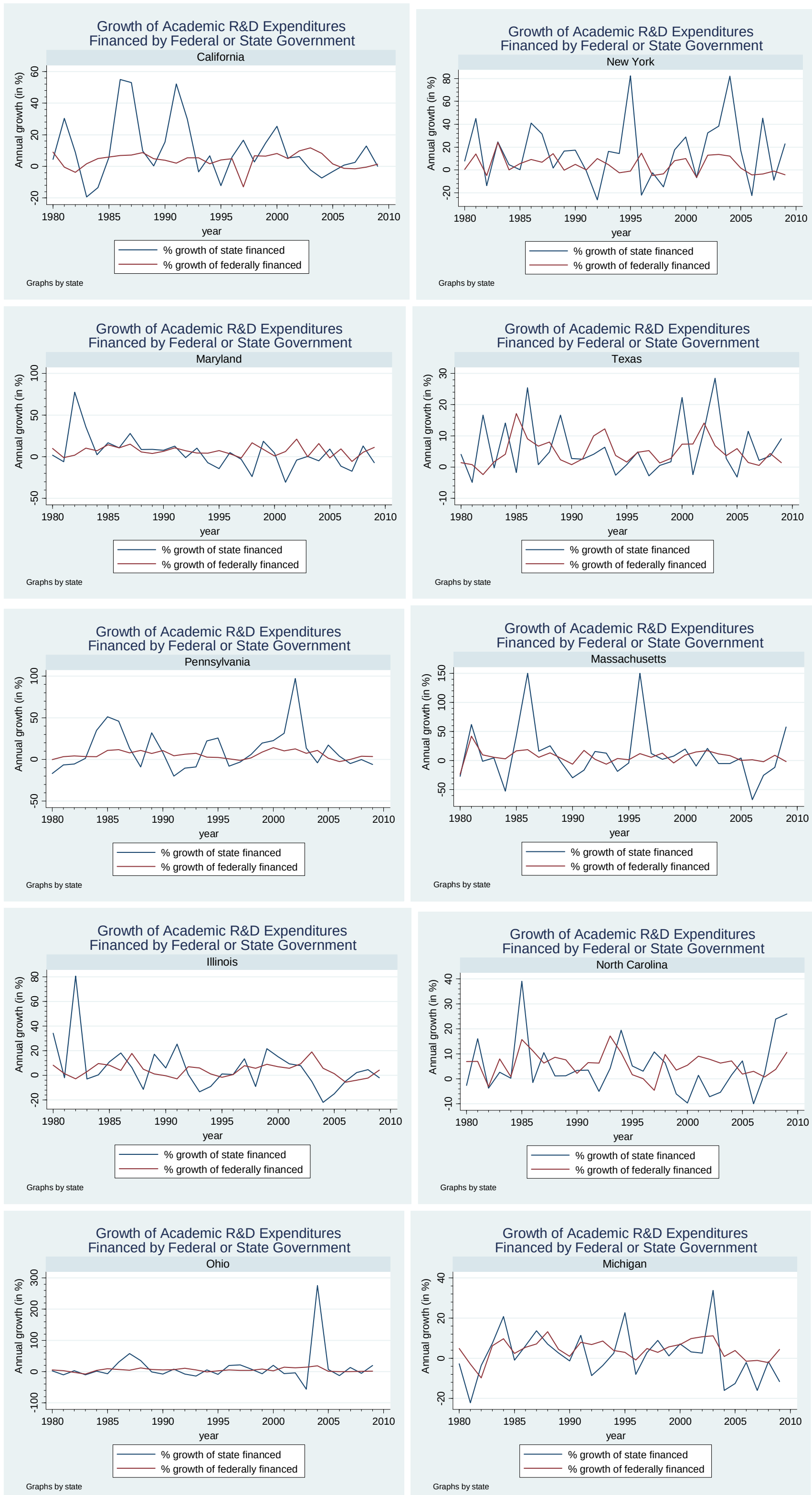

Figure 1: Annual growth of academic R&D expenditures financed by federal and state government

Table 3: Change of growth of academic R&D expenditures financed by federal and state government

State	Increasing growth of federal funding		Decreasing growth of federal funding	
	Increasing growth of state funding	Decreasing growth of state funding	Decreasing growth of state funding	Increasing growth of state funding
California	7	8	5	9
New York	10	6	8	5
Maryland	6	8	9	6
Texas	9	6	6	8
Pennsylvania	10	5	6	8
Massachusetts	9	4	9	7
Illinois	5	7	8	9
North Carolina	9	4	8	8
Ohio	6	8	8	7
Michigan	10	6	7	6
50-state	359	346	362	383

Note: The table entries are counts of observations. The states are the top ten recipients of federally financed academic expenditures in the period 1979-2008.

Table 4: Descriptive statistics

Variable	Obs.	Median	Mean	Std. Dev.	Min.	Max.
Annual growth of state’s own financed public academic R&D expenditures (in %)	1,400	2.69	9.84	66.24	-94.97	1281.57
Annual growth of state’s federally-financed public academic R&D expenditures (in %)	1,400	5.13	5.51	9.93	-45.69	121.12
Annual growth of state’s personal income (in %)	1,400	3.14	3.16	2.53	-12.44	20.23
Annual growth of state’s annual spending on higher education (in %)	1,400	3.62	3.89	7.26	-25.31	94.69

Source: The data of state’s annual own financed public academic R&D expenditures and state’s annual federally-financed public academic R&D expenditures are from NSF’s *Survey of research and development expenditures at universities and colleges*; The data of state’s annual personal income are from BEA’s *Regional economic accounts*; The data of state’s annual expenditures on higher education are from Census Bureau’s *State and local government finances*.

Note: The statistics are based on a panel of 50 states over 1979-2007. All annual growth values are calculated after the dollar amounts are converted into constant dollars using GDP implicit price deflators (the base year is 2005).

Table 5: Statistical results

Variable	Fixed effects (1)	Fixed effects (2)	Fixed effects (3)
Annual growth of state's personal income (in %)	0.8389 (0.7519)	0.9756 (0.7659)	0.406 (0.949)
Annual growth of state's annual spending on higher education (in %)	0.1198 (0.2485)	0.1439 (0.2515)	0.0998 (0.2615)
Annual growth of state's federally-financed public academic R&D expenditures (in %)	-0.5144*** (0.1814)	-0.4686** (0.1839)	-0.6904*** (0.2008)
Constant	9.5551*** (3.1883)	15.1717*** (4.4459)	4.4064 (9.7009)
State fixed effects	Yes	Yes	Yes
State trends	No	Yes	Yes
Year fixed effects	No	No	Yes
N	1,400	1,400	1,400
R-squared - overall	0.0052	0.0017	0.0087
R-squared - within	0.0071	0.0534	0.0791
R-squared - between	0.1283	0.3636	0.3586

Note: The dependent variable is the *annual growth of state's own financed public academic R&D expenditures (in %)*. The fixed effects results are from panel estimation with state fixed effects. Standard errors are in parentheses. *** denotes significance level <1%, ** for 5%, and * for 10%.