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Determinants of the Demand for State Agricultural Experiment Station Resources: A Demand-System Approach

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Abstract: We document the decline in traditional federal government support of the state agricultural experiment station system over the 20 years period starting in 1980 and of state government support over the 1990s. This paper presents a model of state government decisions on agricultural research expenditures. The model permits some benefits to be private in the sense that they are state specific and others to be public and spillover to other states. To capture a key aspect of agricultural research, the model includes voluntary and nonvoluntary contributions to a state government's expenditures on agricultural research. Moreover, we argue that different types and sources of contributions to a state's agricultural research expenditures can be expected to differ in their potential for private and public good production. The econometric model treats federal grants, federal formula funds and private contract, and a state's own appropriates for agricultural research as separate inputs in a state government's demand system for agricultural research. Involuntary transfers are from interstate public and within state spillins. The demand system is fitted to a panel of 48 contiguous states over 1970 to 1999. These results show that the income elasticity of demand for federal grants and private contracts is larger than one (elastic), for state funds is approximately one, and for federal formula funds is significantly less than one (inelastic). We also show that the national ranking of graduate doctorate faculty in basic-biological science and capacity in the agricultural experiment station for basic biological science research increase the demand for federal grant and contract resources. The demand for state government support of SAES research is increased by a high Gourman ranking of graduate agricultural science programs.

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Determinants of the Demand for Agricultural Experiment Station Resources: A Demand-System Approach

The state agricultural experiment stations (SAES) were established with federal funding by the Hatch Act in 1887. Initially all states received exactly the same amount, $15,000 per year. A new formula was established in 1955, and it is used to allocate Hatch and other so called federal formula research funds appropriated by Congress among the states. The Hatch formula allocates 20 percent of the total to each state equally, 26 percent according to a state's percentage of the U.S. farm population, and 26 percent according to a state's percentage of the U.S. rural population. In addition, 25 percent was allocated to cooperative regional research, now called multi-state research, and 3 percent for administration. The USDA first established a competitive grants research program in 1977 to address high-priority research areas. In 1985 it was amended to emphasize biotechnology, and in 1990 it was labeled the National Research Initiative (NRI) Competitive Grant Program (NRC 1995). Other, sometimes significant, USDA competitive research programs include the Fund for Rural America and The Initiative for Future Food Systems which were first initiated in 1996 and 2000, respectively. The latter programs, however, have not received stable funding.

The State Agricultural Experiment Station system was established with the opportunity to obtain funding from a variety of sources, including state government appropriations. Over the last half-century, major sources of funding have been state appropriations; federal formula funding; federal grants, contracts, and cooperative agreement; and private industry, commodity group, and NGO funding. The shares associated with each major source have been changing over time, and recently there has been much discussion and debate about possibly reducing federal formula funds and increasing competitive grants (Huffman and Just 1994, 1999, 2000; NRC 2000; Alston, Pardey, and Taylor 2001; Echeverra and Elliott 2001).

A surprisingly small amount of research has been undertaken to model funding of state agricultural experiment stations. A few exceptions do exist. First, Khanna, Huffman, and Sandler (1994) presented econometric evidence for two different public-good formulations of a state legislature's demand for public agricultural research activity; pure public and joint-product models. Using state annual data for 48 contiguous states, 1951 to 1985, they found overwhelming support for a joint-products public goods model of state government demand for agricultural research. Although parameters differed across states, the income elasticity of demand was overwhelmingly in the 0.5 to 0.8 range and the price elasticity of demand was negative. Evidence existed of a regional public good and a local private good being produced by SAES research. Hence, the evidence supported an impure versus pure public goods model. Although a state can in principle free-ride on the SAES research in other states for the public good producing part, it cannot free-ride on others for the local private good part. Hence, the model is one of impure public good production from research inputs. Second, Rubenstein, Heisey, Klotz-Ingram, and Frisvold (2002) evaluate different federal funding mechanisms for distributing funds to state-level institutions and scientists for agricultural research. They also use a regression model to test some hypotheses concerning the effects of various factors on the ability of states to receive funding through federal competitive-grants programs. They showed that the distribution of formula funds and federal competitive grants are similar by research-problem area (RPA) but special-grants distribution differs markedly. Competitive grants are, however, more basic research oriented. They found that a state university's strength or rankings of biological science programs and graduate program in agricultural sciences were important determinants of a state's federal grants share. The size of a state's agricultural sector and of the Ph.D.-agricultural scientist manpower also contributed positively to the federal grants share.

This paper presents a model of state government decisions on agricultural research expenditures. The model permits some benefits to be private in the sense that they are state specific and others to be public and spillover to other states. To capture a key aspect of agricultural research, the model includes voluntary and nonvoluntary contributions to a state government's expenditures on agricultural research. Moreover, the different types of contributions to a state's agricultural research expenditures can be expected to differ in their potential for private and public good production. A state legislature is assumed to maximize utility from the public and private goods produced from research inputs subject to a budget constraint. We propose a demand system covering four major research input types--federal grants and contracts, federal formula funds, state government funds for agricultural research, and private contracts. This demand system is modeled as a set of share equations, and is fitted to a panel of 48 contiguous states using annual data for 1970 to 1999. These results provide considerable explanatory power for research resource demand and new information on the income elasticity of demand for each major input type.

A Brief Review of the Current Funding Situation

The amount and allocation of resources to the SAES system are reported in table 1 for 1980, 1990, and 2000. The grand total of all SAES system resources increased by 16.3 percent (in constant 2000 dol.) over 1980 to 2000. The largest percent growth was in private (industry, commodity groups, and foundation funds) and of other federal government research funds (but not regular federal appropriations) of 67 and 51 percent, respectively. See table 1. In contrast, regular federal appropriations to the state agricultural experiment stations (those administered by CSRS or CSREES) declined by 9.6 percent over this period, and Hatch and other formula funds declined by 42.3 percent. NRI Competitive and CSRS/CSREES special grants have increased. The USDA had a negligible competitive grants program in 1980, but the National Research Initiative Competitive Grant Programs was established in 1990 and NRI funds going to the state agricultural experiment stations increased from 27.2 million in 1990 to 44.7 million in 2000. CSRS/CSREES special grants are congressional earmarks in which a congressman attaches a provision to a USDA agency's budget that specifies an amount of research funds "pass through" CSRS/CSREES to a particular state's agricultural research institution. The increase in these funds was $24.4 million over 1980 to 2000. Other CSRS/CSREES administered funds are a mixture of types—could be other competitive or non-competitive grants or federal pass through funds from another federal agency. Although federal formula funding has declined in real terms, it remained the larger part of regular federal funding for state agricultural experiment stations.

Finally, the amount of funds from state governments increased over the 1980s, but it then declined over the 1990s. The weakening of state support for SAES research in the 1990s is a new phenomena and it might signal a trend that could continued into the 21st century. Hence, SAES directors have reasons for concern.

As the above discussion suggests, the distribution of SAES resources has also shifted somewhat over the past two decades ending in 2000. The share of SAES funding from federal-formula funding has decreased from 15.1 percent in 1980, to 10.2 percent in 1990 to 8.4 percent in 2000 (Table 1). Hence, the largest drop is in the share of federal formula funds occurred during the 1980s rather than the 1990s. NRI competitive grant funding started in 1990 and was 2 percent in 2000. Special grants were 1.2 percent of resources in 1980 and 2.1 percent in 2000.

Other federal-government resources going to SAES research was 11.4 percent of the grand total funding in 1980, 12.1 percent in 1990, and 16.2 percent in 2000 (table 1). The growth in this share has been primarily in non-USDA federal grants and contracts. State appropriations remain a dominant source of SAES funding, accounting for 55 percent of the total in 1980 and 1990 but declining to 50.1 percent in 2000. Other SAES funds from private industry, commodity group, and foundation funding have also been increasing; 9.2 percent of the grand total in 1980, 13.2 percent in 1990, and 15.3 percent in 2000. Hence, the relative importance of different major sources of funding for the states agricultural experiment stations has been changing over the past two decades. In contrast, the USDA's research agencies—ARS and ERS—show no significant change in funding sources. They are funded almost exclusively by federal government appropriations (see appendix table A1.)

A Model of Funding Shares

In this paper, we treat a state government's decisions on agricultural research expenditures as separable from other state expenditure decisions. The model permits some benefits of agricultural research to be private (a commodity that is a private good) in the sense that it is state specific and others to be public (a commodity that is a public good) and spills over to other states. To capture a key aspect of agricultural research, the model includes voluntary and nonvoluntary (federal, state, and private) contributions to a state government's expenditures on agricultural research. Moreover, we argue that different types and sources of contributions to a state's agricultural research expenditures can be expected to differ in their potential for private and public good production.

Rather than focus on each state's decision for the research associated public and private goods, we shift the emphasis to the demand for research. A state legislature is assumed to maximize its utility from research resources subject to a budget constraint, including in-kind transfers.[1] Local scientific, agricultural, and demographic conditions will affect the translation of research input into public and private goods and, hence, affect the translation of research inputs from voluntary and involuntary contributes into utility of a state legislature.

We focus on the demand for four different types of research resources: (i) federal formula funds (ii) federal grants, contracts, and cooperative agreements, (iii) state government appropriations for research, and (iv) private industry, commodity groups, and NGO'S contracts and grants. Lets assume that the preferences of the state legislature for inputs can be approximated by an almost-ideal-demand system (Deaton and Muelbauer 1980), which gives the following research share equations:

(1) $s_{it} = \alpha_i + \beta_i \ln(F_t/P_t) + \gamma_{i1} K_{1t} + \gamma_{i2} K_{2t} + \mu_t$, $i = 1, 2, 3, 4$,

where s_{it} is the i-th resource share in year t, F_t is the total SAES revenue or expenditures from all sources in year t (or the budget constraint), and P_t is the research price index in year t. K_{1t} is a vector including variables in the federal research funding formula, indicator of interstate public agricultural research spillin potential due to SAES and USDA research conducted in other states, and an indicator of within state private agricultural research spillin potential. K_{2t} is a vector of translating variables (a state's scientific, agricultural, and political conditions).[2] The variable μ_t is a zero mean random disturbance term.

In each time period, the input shares sum to unity i.e., $s_1 + s_2 + s_3 + s_4 = 1$. For estimation purposes, one of the four share equations can be deleted, and its coefficients can then be recovered from the other three equations. For example, let's drop the fourth share equation, then $\alpha_4 = -\alpha_1 - \alpha_2 - \alpha_3$, $\beta_4 = -\beta_1 - \beta_2 - \beta_3$, and $\gamma_4 = -\gamma_1 - \gamma_2 - \gamma_3$. Note that equation (1) also imposes the condition of homogeneous of degree zero in total expenditures (F_t) and the price index (P_t), i.e. revenue shares are a function of the size of total revenue/expenditures in constant rather than current dollars.

Given equation (1) the elasticity of demand for each of the four research types can be summarized as follows:

(2) $\eta_{iF} = 1 + \beta_i/s_i$

(3) $\eta_{iK} = \gamma_i/s_i K$.

Equation (2) gives the income elasticity of demand for the i-th type of research activity, and equation (3) give the elasticity of demand for the i-th type of research activity with respect to a 1 percent change in K.

The Data and Empirical Results

A panel data set covering the 48 contiguous states, 1970 to 1999, or 1,440 observations are used to fit the research input share equations.

Data

The dependent variables are the SAES-input shares, and the regressors are the real budget constraint (i.e., total SAES expenditures or revenue divided by the Huffman and Evenson research price index), variables associated with the federal formula, interstate and within state research spillins and translating variables. See table 2. Each state's lagged share of the U.S. farm population and of the rural population is included to capture federal formula determinants. Our indicator of interstate public agricultural research spillin-potential is the stock of public agricultural research from other states within the same region. The regional subgroups are the same as those used by Khanna, Huffman, and Sandler (1994).[3] The indicator of private agricultural research spillover potential is a private agricultural stock variable constructed from agricultural patents awarded in each state (see Johnson and Brown).

The quality of local graduate education and research is measured by two indicators. One is the Gourman ranking of a local land grant university's graduate program in agricultural sciences. Dummy variables are assigned to a land grant university being in the "Top-10," and

"2rd-10" (relative to 3rd-10 or lower).[4] A second is from National Research Council quality ratings of doctorate program faculty in biochemistry, microbiology, and botany. One of four dummy variables is assigned if the local land grant university is ranked "Good-to-Strong (relative to Strong-to-Distinguished), Adequate-to-Good, Marginal-to-Adequate, and Insufficient-to-Marginal. Also, some agricultural experiment stations have a heavier emphasis on basic or pre-invention science emphasis than others and this reputation and capacity may affect the demand for research inputs. This factor is represented by the lagged value of SAES resources allocated to basic biological science research.

Additional variables are the share of a state's population that is farm and is rural, composition of farm sales in 1982, and seven regional indicators which represent regional-fixed effects which are time invariant.

Results

The econometric model contains some unusual attributes which affect the estimation strategy. For each observation, the four input share equations add up to unity (1). This means that one share equation is redundant, and its coefficients can be recovered from estimates of the other three share equations. In estimation, we choose to delete the share equation for "other" resources. Also, a disturbance to any one equation will be at least partially transmitted to other share equations. This creates contemporaneous correlation of disturbances in the three-fitted share equations to be fitted, and we apply an estimation procedure that is equivalent to Zellner's seemingly-unreality least-squares estimation (Greene 2002, p. 340-248).

Our data set, which is a panel of states, 1970-1999, has 1,440 observations. The estimated coefficients and t-values for three share equations are reported in table 3, and the implied coefficient for the coefficients of the fourth equation are also included in the last column of the table. The results are surprisingly strong. The null hypothesis that each of the share equations individually has no explanatory power is clearly rejected. The test has 23 and 1,410 degrees of freedom and a critical value at the 1 percent level of about 2.77. The sample value of the F-statistic is 60.0 for the federal grant share equation, 236.1 for the federal formula funding equation, and 30.3 for the state appropriations equation. Furthermore, if one were to pool the results across all three-share equations into one joint test of no explanatory power, the null hypotheses would be soundly rejected at the 1 percent level. Hence, our model of state demand for these three types of public agricultural research activity has explanatory power.

Turning to individual regressors, the budget constraint is a statistically significant explanatory variable in the three fitted share equations, holding constant public and private agricultural research spillins. Its coefficient is positive for federal grants and contracts and other SAES sources and negative in share equations for state and federal formula resources. These coefficients also have important implications for the income elasticity of demand for research inputs, which will be presented later.

The estimated coefficient for a state's share of the U.S. farm populations is positive and significant in the equation for the SAES federal formula funding share but also for the SAES state government and federal grants and contracts shares. The impact on the SAES federal grants and contracts share is somewhat surprising; one might expect no effect. These results also imply that the impact of a larger U.S. farm population share is to reduce the share from "other" SAES sources. The estimated coefficient for the state's share of the U.S. rural population is also positive in the federal formula funding share equation.

Spillins of interstate public (SAES and USDA) agricultural research or of within state private agricultural research reduce the share for or demand for federal formula funds. One interpretation is that these spillins are substitutes for federal formula funds. Also, within state private research spillins substitute for voluntary private contributions to SAES research. Within state private research spillins also increased the share of or demand for federal grants and contracts. These private agricultural research spillins, which are mainly applied research or invention related, seem to be complementary with less applied federal grant and contract research.

A Gourman ranking of top-10 or 2nd-10 relative to a lower ranking in the local land grant graduate agricultural science programs increases state government agricultural research funding significantly—17.9 percent for top-10 and 9.5 percent for 2nd-10. These large positive effects are offset by negative impacts on the other three funding shares. Hence, the state government reacts as if it places significant weight on the Gourman index, even if it faces some academic criticism.

NRC ratings of a land grant university's doctorate program faculty in the basic-biological-sciences (i.e., average of the rankings of biochemistry, microbiology and botany) are important. Being rated below the top category, which is "Strong-to-Distinguished," reduces the federal-grants share by 6 to 7.5 percentage points, with little difference in the size of the reduction occurring as a university moves down to "Marginal-to-Adequate" or "Insufficient-to-Marginal." However, being below the "Strong-to-Distinguished" category increases the SAES share from "other" SAES sources by 4 to 12.5 percentage point with larger increases being for the lowest ranking. The federal formula funding share is largely unaffected by a university's NRC faculty quality ranking.

The capacity of an agricultural experiment station for basic biological science research can be built through investments in this area. In our model, SAEA with a large basic biological science capacity, as reflected in the lagged value of the share of basic-biological science research, increases the demand for federal grant and contract funding. This, however, is offset largely by a reduction in federal formula and state funding.

When a state has a larger share of its population on farms, it increases the demand for state resources and federal formula research resources. This implies that these resources serve farmers' interests well. The commodity mix of a state's agriculture also impacts demand for research resources. Our results show statistically significant regional effects, which are measured relative to the Central Region. They suggest other things equal, that the North Central Region (and Mountain Region) has larger demand for federal grants and contracts relative to all other regions. The Southern Plains, Southeast, Northeast, and Mountain Region have larger demand for state appropriations relative to all other regions.

We believe that the results in table 3 provide new information about the demand by the states for SAES research. Using equation (2) and evaluating it at the sample mean of the data set, we obtain income elasticity of demand for voluntarily contributed research. For federal-grant-research, the income elasticity is 1.58, for federal-formula-funded research is 0.4, for state-government-funded research is 0.96, and for other SAES, largely privately-funded research, is 1.35. Hence, as experiment station resources grow in real terms, the most rapid growth will be in federal grants and contracts and private sector contracts and grants.

If a state land grant university can move up to the top quality NRC ranking of its basic biological science faculty, e.g., from "Good-to-Strong" to "Strong-to-Distinguished" this will increase the state level demand for federal grants and contracts and for state government funds for agricultural research but reduce the demand for other resources for research. If state agriculture experiment stations increase their emphasis and capacity in basic biological sciences, the demand for federal grants and contracts will increase. This, however, would be expected to require a large investment in scientific expertise and hence comes at a significant resource cost.

Conclusions

This paper has documented changes in the funding environment of state agricultural experiment stations over the last two decades of the 20^{th} century. It has applied a conceptual model from public finance to explain state government decisions on agricultural research expenditures which production public and private goods. A demand system is fitted to a panel data set of 48 states over 1970 to 1999.

These results show that the state level income elasticity of demand for federal grants and private contracts is larger than one (elastic), for state research funds is approximately one, and for federal formula funds is significantly less than one (inelastic). Hence, if larger total real resources are spent on SAES research, it seems likely to come disproportionately from federal grants and contracts and from private sector contracts and grants. These new directions may seem at odds with one another. We also show that the national ranking of a land grant university's graduate faculty in basic-biological sciences and basic biological science capacity of an agricultural experiment station will increase the demand for federal grant and contract research resources. State government support is increased by a higher Gourman ranking of graduate agricultural science programs in land grant universities.

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Table 1. Amount and Distribution of Major Sources of Revenues of U.S. State Agricultural Experiment Stations, 1980-2000.

Sources	Current Dol., Millions			Constant 2000 Dol.[a], Millions			Distribution (%)		
	1980	1990	2000	1980	1990	2000	1980	1990	2000
Regular federal appropriations	136.9	223.6	292.6	322.1	304.6	292.6	17.0	14.0	13.1
Hatch and other formula funds	121.2	163.9	186.9	285.1	222.5	186.9	[15.1]	[10.2]	[8.4]
CSRS/CSREES special grants	9.6	39.7	47.0	22.6	54.1	47.0	[1.2]	[2.5]	[2.1]
Competitive grants, including NRI	--	20.0	44.7	--	27.2	44.7	--	[1.2]	[2.0]
Other CSRS/CSREES administered funds	6.1	0.6	14.0	14.4	0.8	14.0	[0.7]	[0.1]	[0.6]
Other federal government research funds	91.8	193.3	360.4	216.0	263.7	360.4	11.4	12.1	16.2
Contracts, grants, and cooperative agreements with USDA agencies	24.4	49.5	75.0	57.4	67.5	75.0	[3.0]	[3.1]	[3.4]
Contracts, grants, and cooperative agreements with non-USDA federal agencies	67.4	143.9	285.4	158.6	196.3	285.4	[8.4]	[9.0]	[12.8]
State government appropriations	446.9	877.9	1,117.8	1,051.5	1,197.7	1,117.8	55.5	55.0	50.1
Industry, commodity groups, foundations	74.0	210.0	340.9	174.1	286.5	340.9	9.2	13.2	15.3
Other funds (product sales)	55.2	91.6	118.0	129.8	125.0	118.0	6.9	5.7	5.3
Grand total	804.8	1,596.5	2,229.7	1,893.6	2,178.0	2,229.7	100.0	100.0	100.0

Source: U.S. Dept. Agr. 1982, 1991, 2001.

[a]Obtained by deflating data in first three columns using the Huffman and Evenson (1993, p. 95-97 and updated to 2000) agricultural research price index with 2000 being 1.00.

[b]Amount received from industry and "other non-federal sources," excluding state appropriations and product sales or self-generated revenue.

Table 2. Variable Names and Definitions

Name	Symbol	Mean (St.D.)	Description
Budget share from federal grants and contracts	GR	0.115 (0.086)	The share of the SAES budget from National Research Initiative, other CSRS funds, USDA contracts, grants and cooperative agreements, and nonUSDA federal grants and contracts (USDA).
Budget share from federal formula funds	SFF1	0.183 (0.104)	The share of the SAES budget from Hatch, Regional Research, McIntire-Stennis, Evans-Allen, and Animal Health (USDA)
Budget share from state government appropriations	SFF2	0.524 (0.119)	The share of the SAES budget from state government appropriations (USDA)
Budget share from "other" funds	OR	0.178	The share of the SAES budget from private industry, commodity groups, NGO's and SAES sales (USDA)
Total SAES revenue 1984 dol.	REVP	9.624* (0.872)	The total SAES funds from all sources divided by the Huffman and Evenson (1993) research price index (1984=1.00)
U.S. farm population share		0.021 (0.015)	A state's share of the U.S. farm population in the last census of population (U.S. Dept. Comm.)
U.S. rural population share		0.021 (0.015)	A state's share of the U.S. rural population in the last census of population (U.S. Dept. Comm.)
Public agricultural research spillin		18.018* (0.248)	The summation across all states in a region of the public agricultural research stock less a state's own contribution to the stock (see Khanna, Huffman and Sandler 1994). Each state's research stock derived in Huffman and Evenson 2003.
Private agricultural research capital private		6.076* (0.248)	A state's stock of private patents of agricultural technology. The number of patents (Johnson and Brown) for each year obtained by weighting the number of patents in field crops (excluding fruits and vegetables and horticultural and greenhouse products) and crop services; fruits and vegetables; horticulture and greenhouse products; and livestock and livestock services by a states 1982 sales share in field crops (excludes fruits, vegetables, horticultural and greenhouse products), fruits and vegetables, horticulture and greenhouse products and livestock and livestock products, respectively. Trapezoidal timing weights are applied to the 2 thru 18 year lagged patent totals and summed

		to obtain the private R&D stock (Huffman and Evenson 2003).
Agricultural sciences rating		The Gourman (1985) rating of graduate programs in agricultural sciences—Dummy variable taking a value of:
Top10	0.208 (0.406)	1 if an institution is rated in Top 10, and 0 otherwise
2nd 10	0.188 (0.390)	1 if an institutions is rated 11-20, and 0 otherwise
<20th	0.604	1 if an institution is rated below top 20, and 0 otherwise.
Quality of graduate basic biological science faculty		National Research Council (1982) rating of scholarly quality of doctorate program faculty averaged over biochemistry, microbiology, and botany. Dummy variable taking a value of:
Strong-to-Distinguished	0.062	1 if institution has average rating of 4 to 5; and 0 otherwise;
Good-to-Strong	0.167 (0.373)	1 if institution has an average rating of 3.0 to 3.99; and 0 otherwise
Adequate-to-Good	0.354 (0.478)	1 if institution has an average rating of 2.0 to 2.99; and 0 otherwise.
Marginal-to-Adequate	0.146 (0.353)	1 if institutions has an average rating of 1.0 to 1.99; and 0 otherwise
Insufficient-to-Marginal	0.271 (0.444)	1 if institution has an average value of 0 to 0.99; and 0 otherwise.
Share research investment in basic biological sciences$_{-2}$	0.219 (0.070)	Share of SAES budget allocated to the fields of science of biochemistry and biophysics, molecular biology, genetics, microbiology, biology genetics, microbiology, and physiology lagged 2 years (USDA)
U.S. farm population share	0.021 (0.015)	A state's share of the U.S. farm population in the last census of population (U.S. Dept. Comm)
U.S. rural population share	0.021 (0.015)	A state's share of the U.S. rural population in the last census of population (U.S. Dept. Comm)
State farm population share	0.037 (0.040)	The share of a state's population that is farm (U.S. Dept. Comm)
State rural population share	0.345	The share of a state's population that is rural (U.S. Dept Comm)

		(0.152)	
Farm Sales in 1982:			
Share field crops, excluding fruits, vegetables, horticulture and greenhouse crops		0.322	The share of a state's farm sales in 1982 that were in field crops, excluding fruits, vegetables, horticultural and greenhouse products (USDA)
Share fruits and vegetables		0.102 (0.122)	The share of a state's farm sales in 1982 that were fruits and vegetables (USDA)
Share horticulture and greenhouse		0.045 (0.074)	The share of a state's farm sales in 1982 that were horticulture and greenhouse products (USDA)
Share livestock		0.531 (0.171)	The share of a state's farm sales in 1982 that were livestock and livestock products
Regional indicators	Northeast	0.229	Dummy variable taking a 1 if state is CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, or VT; and 0 otherwise;
	Southeast	0.188	Dummy variable taking a 1 if state is AL, FL, GA, KY, NC, SC, TN, VA, or WV; and 0 otherwise
	Central	0.167	Dummy variables taking a 1 if state is IN, IL, IA, MI, MO, MN, OH, or WI; and 0 otherwise
	North Plains	0.083	Dummy variable taking a 1 if state is KS, NE, ND, or SD; and 0 otherwise;
	South Plains	0.104	Dummy variable taking a 1 if state is AR, LA, MS, OK, or TX
	Mountains	0.166	Dummy variable to buy a 1 if state is AZ, CO, ID, MT, NV, NM, UT, or WY; and 0 otherwise;
	Pacific	0.063	Dummy variable taking a 1 if state is CA, OR, or WA; and 0 otherwise.

*Values are in natural logarithms.

Table 3. Econometric Estimates of an Almost-Ideal-Demand System for State Agricultural Experiment Resources, 48 States: 1970-1999 (t-values in parentheses) [N = 1,440]

Regressors[a/]	Revenue/Input Shares			
	Federal Grants & Contracts (1)	Federal Formula (2)	State Appropriations (3)	Other[b/] (4)
Intercept	-1.976	2.435	0.984	-1.443
	(11.80)	(18.84)	(3.69)	
ℓn(Total SAES Revenue, 1984 dol.)	0.067	-0.109	-0.021	0.063
	(16.08)	(34.01)	(3.24)	
U.S. Farm Population Share	0.710	0.137	0.494	-1.341
	(2.61)	(2.20)	(3.86)	
U.S. Rural Population Share	-1.165	0.075	-0.120	1.210
	(5.07)	(5.22)	(4.08)	
ℓn(Public Ag Res Spillin Capital)	-0.003	-0.012	0.010	0.005
	(0.56)	(3.69)	(1.46)	
ℓn(Private R&D Capital)	0.229	-0.165	-0.040	-0.024
	(9.77)	(9.13)	(1.07)	
Ratings of Graduate Programs Ag Science (Gourman):				
Top 10 (=1)	-0.067	-0.002	0.179	-0.110
	(4.95)	(0.18)	(8.26)	
2nd 10 (=1)	-0.020	-0.022	0.095	-0.053
	(2.90)	(4.08)	(8.73)	
Quality Basic Biology Science Faculty (NRC):				
Good-to-Strong (=1)	-0.063	0.003	-0.030	0.090
	(6.21)	(0.37)	(1.85)	

Adequate-to-Good (=1)	-0.075 (6.93)	0.003 (0.35)	0.029 (1.70)	0.043
Marginal-to-Adequate (=1)	-0.064 (5.31)	0.021 (2.30)	-0.082 (4.26)	0.125
Insufficient-to-Marginal	-0.070 (5.60)	-0.007 (0.74)	0.000 (0.05)	0.077
Share SAES Research Inv. in Basic Biolog Science$_{-2}$	0.177 (5.89)	-0.136 (5.87)	-0.021 (3.24)	-0.020
State Farm Population Share	-0.352 (4.36)	0.461 (2.20)	0.494 (3.86)	-0.603
State Rural Population Share	0.044 (2.38)	1.902 (10.73)	-0.123 (4.08)	1.823
Composition of Farm Sales (1982):				
Share fruits & vegetables	0.277 (5.51)	-0.283 (7.30)	-0.010 (0.12)	0.016
Share horticulture & Greenhouse	0.774 (13.30)	0.028 (0.63)	-0.403 (4.36)	-0.399
Share livestock	0.253 (12.82)	0.020 (1.32)	-0.307 (9.78)	0.034
Regional Indicators:				
Northeast (=1)	-0.053 (4.54)	-0.018 (2.03)	0.036 (1.94)	0.035
Southeast (=1)	-0.088 (7.94)	0.012 (1.34)	0.155 (8.74)	-0.079

Northern Plains (=1)	-0.045	-0.041	-0.005	0.091
	(3.54)	(4.18)	(0.27)	
Southern Plains (=1)	-0.086	-0.016	0.138	-0.036
	(7.80)	(1.88)	(7.85)	
Mountain (=1)	0.020	-0.044	0.037	-0.013
	(1.67)	(4.81)	(1.97)	
Pacific (=1)	-0.018	0.033	-0.023	0.008
	(1.53)	(3.60)	(1.23)	
R^2	0.493	0.793	0.330	

Table A1. Total Funds for Research, including Cooperative Agreements, by USDA Research Agencies, 1980-2000

Agency	Current Dollars, Millions			Constant 2000 Dollars[b] Millions		
	1980	1990	2000	1980	1990	2000
Agricultural Research Service	360.3	580.1	794.9	847.8	790.3	794.9
Regular Federal appropriations	360.3	570.9	775.7	847.8	777.8	775.7
Other funds	0	9.2	19.2	0	12.5	19.2
Economic Research Service	42.6	51.3	72.5[a]	100.2	69.9	74.8[a]
Regular Federal appropriations	42.4	51.3	71.6	99.8	69.9	73.9
Other funds	0.2	0	0.9	0.4	0	.9
Total ARS and ERS	402.9	631.4	867.4	948.0	860.2	869.7
Regular Federal appropriations	402.7	622.2	---	947.6	847.7	---
Other funds	0.2	9.2	---	0.4	12.5	---

[a]Data for ERS and for 1999. ERS did not report any data for CRIS for 2000.

[b]Obtained by deflating data in the first three columns using the Huffman and Evenson (1993, p. 95-97 and updated to 2000) agricultural research price index with 2000 being 1.0.

Endnotes

[1] The private good is also a state-specific public good. The model is one with impure public goods (see Cornes and Sandler 1996).

[2] Although this demand system does not contain individual prices for the each of the types of research inputs, it doe contain a summary research price index across all input types (P_t). The name federal formula funds can be misinterpreted to mean that the total quantity of these funds is determined by a formula. This is not true; Congress decides the total amount of formula funds. What is fixed is the rule for allocating this total to each of the states. We take this into account in the empirical specification of the model.

[3] Of course, regional grouping of states always has some arbitrariness.

[4] We take the Gourman ratings at face value. If they do not contain any useful information, they will not have any explanatory power in our demand system. In contrast, if the rates have coefficients that are significantly different from zero, this will be an indication that they matter to the state legislators as the weigh the demand for SAES research funding.