Staff Papers Series

Staff Paper P89-25

July 1989

PUBLIC SUPPORT OF EXPERIMENT STATIONS

Willis Peterson

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture, Forestry and Home Economics
St. Paul, Minnesota 55108

July 1989

PUBLIC SUPPORT OF EXPERIMENT STATIONS

Willis Peterson*

ABSTRACT

Demand functions for teaching, research and extension (TRE) personnel in seven administrative units of U.S. agricultural experiment stations are estimated from panel data, decennial observations, 1950 to 1987. The results reveal that the demand for the services of TRE personnel has not declined in the 1980s, given the demographic and economic conditions of the times. Moreover, there is no evidence to suggest that the long run demand elasticities have declined during the post-World War II period in spite of economic growth. From these results one might conclude that the demand for the services produced by experiment stations will continue to increase as the real value of agricultural production, population, and real per capita income increase. However, substantial variation exists among states in their propensity to support their experiment stations and the various administrative units within the stations.

In view of the depressed state of agriculture during the 1980s and declining enrollments in colleges of agriculture, one might raise the question: what does the future hold in store for agricultural experiment stations and their sister institutions, colleges of agriculture, forestry, home economics and veterinary medicine?[1] Being public institutions, their existence depends on the willingness of taxpayers to allocate tax receipts for their support, in essence to purchase their teaching, research and extension (TRE) services.

In an attempt to answer this question, the first objective of this paper is to inventory the current stock of TRE personnel and compare it to the stocks that existed at earlier points in time. The numbers update those presented in an earlier study (Peterson, 1969), although they are organized and presented differently.

A second objective is to estimate the demand for the services of experiment stations, how this demand may have changed over time, and how it might change in the future. In the last section of the paper, a state-by-state allocation of TRE personnel is presented and compared to the predicted values generated by the demand equations.

Overview

Although total expenditures of experiment stations includes more than the cost of professional TRE personnel, the personnel numbers rather than cost data are used for several reasons. First, they allow us to obtain the allocation of effort within experiment stations by administrative units from an easily accessible, published source (U.S. Department of Agriculture). Data from seven administrative units, mainly departmental groupings, are presented. Second, the degree of confidence one can place in the accuracy of the numbers should be relatively high for the personnel data, which are simply name counts of departmental staff. It is not necessary to rely on secondary cost data gathered from hundreds of thousands of individual transactions. The separation of expenditures between current expenses and capital goods is especially troublesome in measuring costs. Also, the problem of constructing accurate deflators, both cross-sectionally and over time, is avoided with the personnel data. Finally, personnel costs represent a large share of total costs of TRE services, and should be highly correlated with these costs. Therefore the personnel figures should be a reasonably good proxy for total costs, at least in the long run. Granted during a time of depressed economic activity in agriculture and in the overall economy as occurred during the early 1980s, one might expect a temporary softening of support. However, from the standpoint of real salaries, inflation is much more detrimental than recession. From 1970 to 1979, real salaries in U.S. universities decreased about 21 percent, while from 1980 to 1987, almost half of this loss was recouped as real salaries increased nearly 10 percent (American Association of University Professors).

To maintain consistency among observations, the personnel numbers include only professional staff having an academic appointment. Because information on the exact allocation of time of professional staff among teaching, research and extension functions does not exist, a functional separation among teaching, research and extension duties is not undertaken. While the staff lists designate the nature of appointment (college, experiment station, or extension), virtually all names carry two, and many, all three designations. The trend in recent years is away from single-activity towards multi-activity appointments. This is particularly noticeable among extension staff. No one really knows the exact allocation of time among the three activities, particularly between teaching and research, even individual faculty members. To make a separation would imply a false sense of accuracy.

In Table 1, members of TRE personnel in seven administrative units are presented, along with the grand total for the county, by decennial observations, 1950 to 1987.

1. Plant sciences. This category includes the departments of agronomy, horticulture, landscape architecture, plant pathology, entomology, and soils.
2. Animal sciences. This group includes all personnel in the animal, dairy and poultry science areas, as well as veterinary medicine.
3. Agricultural economics.
4. Other agriculture. This group includes the departments of Agricultural Education, Agricultural Engineering, and Rural Sociology. Although they are not similar in their professional orientation, in most states they are relatively small units and therefore are not presented individually.
5. Forestry. Fisheries and wildlife personnel are included within this group as well as national resource and environmental sciences.
6. Home Economics. Many of these units have undergone name changes in recent years, and some have lost personnel to other units such as Food Science and Nutrition, or to other colleges outside of the experiment station. The Home Economics data includes only the personnel within this administrative unit. Substantial differences

TABLE 1.
NUMBER OF TEACHING, RESEARCH AND EXTENSION PERSONNEL
IN U.S. STATE AGRICULTURAL EXPERIMENT STATIONS

	1950	1960	1970	1980	1987
Plant Sciences	3,012	4,372	6,278	7,454	7,401
Animal Sciences	1,875	2,774	3,942	4,683	4,756
Ag. Economics	827	1,187	1,613	1,743	1,639
Other Agric.	893	1,191	1,366	1,526	1,537
Forestry	378	520	1,395	2,064	2,336
Home Economics	1,419	1,650	1,563	1,922	1,828
Other Personnel	2,099	2,868	3,317	4,545	4,642
Total	10,503	14,562	19,474	23,937	24,139

exist among states as to where people who do similar tasks are counted. It is suspected that in some states, they are outside of the experiment station. Therefore, one should take the Home Economics figures with a "grain of salt" and not infer that states with small Home Economics units go without the related services. The same is true of the three departments in Category 4, other agriculture.

7. Other personnel. By and large, this group includes administrative personnel at the experiment station and college levels, as well as personnel in other units such as food science and chemistry--units not closely related to the other six groups. The seven groups include all professional staff of the experiment stations and related colleges.

The overall picture presented by Table 1 is that TRE personnel in experiment stations nearly doubled between 1950 and 1970. The rate of growth declined during the 1970s; after 1980, total experiment station personnel has remained relatively constant. Plant and animal science personnel followed about the same trend as the total, which is not surprising since these two areas account for about one-half of the total. Growth of Agricultural Economics personnel leveled off by 1970 and has remained relatively constant during the 1970s and 1980s. The same is true of the "other agriculture" category. Forestry exhibited the largest percent rate of growth over the entire period, and was the only group to have experienced significant growth during the 1980s. In contrast, numbers of Home Economics personnel remained relatively constant after 1960 and as a result, experienced a substantial decline in their share of the total. The percent rate of growth of the "other personnel" group was most rapid during the 1970s; since 1980, the number of personnel in this group has remained relatively stable. The rather substantial difference in growth (or decline) among the seven categories suggests that change in the overall experiment station support is not necessarily a good indication of change of individual units.

Conceptual Framework

In addition to the paper cited above, several, more recent studies have attempted to identify and measure the factors affecting experiment station funding (Guttman; Huffman and Miranowski; Evenson and Rose-Ackerman; Pardey, Kang and Elloitt). By and large, these studies have shown that economic, political and institutional factors are all influential. A somewhat simpler model is utilized here, focusing on economic and demographic factors. This is not to suggest that political and institutional factors are unimportant. But the main objective of this study is to predict long-run change. Lacking reliable theories of long-run political and institutional change, it is necessary to limit the analysis to economic and demographic variables.

It is hypothesized that the long-run demand for the services of experiment stations is a function of the prices of these services and two demand shifters: 1. a population and 2. per capita income. Because the TRE services produced by experiment stations are not measurable in standardized units such as bushels or dollars, it is necessary to follow the now accepted procedure of using inputs, in this case personnel, as a proxy for output. In essence, this is a derived demand. The demand for experiment station personnel is derived from the demand for their services.

The prices of these services are defined as a reciprocal of the expected rates of return on investment in teaching, research and extension activities--essentially investment in human capital. The price of a permanent income stream is a reciprocal of the rate of return on the investment which produced the income stream (Friedman, Chapter 13). For example, if the rate of return is 20 percent, the price of a one dollar permanent income stream is $5.00. The higher the return, the lower the price.

Real value of related output is used as a proxy for the expected rate of return. For example, value of crop production is the related output for the plant sciences. Other things equal, the higher the related output, the higher the expected rate of return of a given investment (Griliches). Using related output as a proxy for expected rate of return, assumes that the production elasticity of TRE personnel in a TRE production function is constant across states. While this assumption may deviate somewhat from reality, the evidence suggests that related output is the most important factor determining the rate of return in a given state (Bredahl and Peterson).

The demand shifters of population and per capita income can be viewed as measures of market size. The greater the population and per capita income of a state, the greater the demand for the services of experiment station personnel. In part, these demand shifters also define the size of the tax base of a state which, in turn, influences the ability to finance public institutions.

Demand Elasticities

Separate demand functions for the seven categories defined above, plus total personnel, are estimated from panel data, utilizing 48 states for the years 1950, 1960, 1970, 1980 and 1987, n=240. Separability among the seven units is assumed. All equations are in log-log form so that the coefficients are elasticities. Because the elasticities are estimated from cross-section observations, they can be interpreted as long-run estimates.

The results of the demand estimation are presented in Table 2. Related output for the plant and animal sciences is real value of crop and livestock production respectively. (The CPI is used as the deflator). For lack of a better measure, total agricultural production (crops plus livestock) is used as the related output variable for Agricultural Economics, Home Economics, other Agriculture, other Personnel, and Total Personnel. It is recognized that the services of certain units go beyond agriculture. One might consider population and per capita income as additional price variables for these units. The forestry related output variable is the stock of standing timber in each state in board feet. This measure was adjusted to reflect the changes in the real price of lumber over time. Although the real price of lumber increased during the 1970s, the long run (1950-1987) trend of real lumber prices has been downward.

The related output or price variable enters with a positive coefficient because it is measured as a whole number rather than a reciprocal. Because the equations are in log-log form, the same coefficient except with a negative sign would have been obtained if the

TABLE 2
DEMAND EQUATIONS*

Dependent Variable	Independent Variables: Related Output	Independent Variables: Population	Independent Variables: Per Capita income	R^2
Plant Sciences	.360(15.0)	.227(7.06)	.619(9.41)	.792
Animal Sciences	.418(15.1)	.277(8.92)	.466(6.61)	.753
Ag. Econ.	.355(13.0)	.194(6.25)	.378(5.71)	.704
Home Economics	.210(4.16)	.256(4.46)	.227(1.87)	.317
Other Agriculture	.470(15.8)	.212(6.28)	.160(2.23)	.744
Forestry	.372(7.96)	.428(5.75)	1.22(6.68)	.491
Other Personnel	.280(8.94)	.292(8.20)	.435(5.74)	.662
Total Personnel	.325(15.2)	.273(11.2)	.504(9.68)	.823

*Figures in parentheses are t-ratios.

reciprocal of related output had been used instead. Thus one can envision these demand curves as downward sloping: the greater the output, the lower the price of a permanent income stream, and the greater the quantity demanded.

All the coefficients, with the exception of the Home Economics income elasticity, are statistically significant at relatively high confidence levels. One might infer from these results that long run growth in agricultural output, population and per capita income will lead to continued growth in the number of professionals employed by agricultural experiment stations. How much growth occurs will depend on the magnitude of growth of these three variables. With the exception of Ag. Econ., Home Economics, and other Agriculture, the elasticities sum to one or greater suggesting greater than proportionate growth in the other areas and in total personnel.

The above proposition will hold true only if the demand functions do not undergo an unexplained downward shift, and/or the elasticities do not decrease over time. However, future changes in the parameters of the demand functions are even more difficult to predict than changes in the independent variables. Is there any evidence to suggest that the intercepts and demand elasticities are decreasing?

In an attempt to shed some light on this question, the demand equations shown in Table 2 were estimated with intercept and slope dummies for the different points in time. The intercept dummies for the demand functions estimated without slope dummies are shown in Table 3. The reference dummy is 1970. A negative coefficient indicates that the demand equation is lower for the year in question than in 1970.

TABLE 3
INTERCEPT DUMMIES

Dependent Variable	1950	1960	1980	1987
Plant Sciences	-.591(-7.72)	-.297(-4.16)	-.004(-.060)	.061(.868)
Animal Sciences	-.680(-8.43)	-.293(-3.98)	.095(1.33)	.170(2.28)
Ag. Econ.	-.792(-11.5)	-.375(-5.82)	.0008(.013)	.068(1.06)
Home Economics	.043(.267)	.172(1.13)	.024(.166)	-.071(.473)
Other Agriculture	-.559(-6.53)	-.236(-2.98)	.078(.935)	.213(2.79)
Forestry	-1.08(-4.63)	-.870(-4.04)	.330(1.61)	.435(2.02)
Other Personnel	-.318(-3.37)	-.094(-1.87)	.243(2.91)	.309(3.56)
Total Personnel	-.550(-10.0)	-.261(-5.12)	.113(.048)	.176(3.51)

*Numbers in parentheses are t-ratios.

Except for Home Economics, all the 1950 and 1960 intercept dummies are negative indicating that the demand functions shifted upwards between these years and 1970. Experiment stations experienced rapid growth during the 1950s and 1960s, more than would be predicted by the growth in agricultural output, population and per capita income. A possible explanation for the high rate of growth during the 1950s and 1960s is a catching up after the unusual circumstances of the previous two decades - the Great Depression and World War II.

Except for plant science in 1980 and Home Economics in 1987, all the 1980 and 1987 intercept dummies are positive, indicating an upward shift of these demand functions after 1970. However, relatively few are statistically significant, particularly for 1980. Except for "other Personnel", it appears that the demand for TRE personnel did not undergo significant unexplained upward shift between 1970 and 1980. The 1987 intercept dummies are slightly larger and more are statistically significant. However, one should bear in mind that the real value of U.S. agricultural output declined by over 26 percent between 1980 and 1987, a major departure from its long run growth path. Since personnel numbers are relatively stable from year to year, the results give the appearance of an upward shift in the demand function. One would expect the real value of agricultural output to recover to a more normal level in the 1990s and beyond. When this occurs, the intercept dummies should return to the nonsignificant values of 1980. At any rate, one should not conclude that the demand for TRE personnel has shifted upwards in the 1980s based on 1987 data alone.

To test for change in the elasticities over time, the demand equations were estimated with slope dummies assigned according to time, 1970 the reference dummy. With just one exception, a positive per capita income dummy for the plant sciences in 1960, all the slope dummies for all eight demand equations were statistically insignificant at normally accepted confidence intervals. Therefore, the specific coefficients are not shown. (The one exception is likely to be a statistical anomaly.) From these results, it seems reasonably safe to conclude that the price, population and income elasticities of demand for TRE services have remained constant over the 1950-87 period. At least there is no evidence to suggest that the elasticities are declining.

The stability of the income elasticity is unexpected and remains a puzzle. Between 1950 and 1987, real per capita income in the U.S. increased 82 percent. According to Engel's Law, the income elasticity of demand for food should have declined as incomes increased. Yet the income elasticity of demand for TRE services, which is an important component in the production of food, appears to have not declined. Apparently experiment stations are viewed by the public as producing a broader array of services than strictly food oriented. Experiment stations themselves have been promoting this image as they have moved towards broadening their teaching, research and extension clientele. It appears they have been successful in this endeavor.

State-Specific Allocations

The demand equations provide national average changes in TRE personnel in response to changes in the independent variables. However, what is true for the nation may not hold true for an individual state.

For example, states which have a greater than predicted number of TRE personnel in a specific area or unit, may adjust their numbers downward while other states with fewer than predicted personnel, grow. To provide more specific information on individual states, the actual numbers of 1987 TRE personnel for the eight groups are presented in Table 4, along with the ratio of actual over predicted (A/P) values. If this ratio is greater than one, it is an indication that the state has been more generous in its support, given its economic and demographic base, than the national average, and vice versa if the ratio is less than one.

The predicted values are obtained from the equations shown in Table 2 plus the constant term.[2] For example, the predicted state values of TRE personnel in the plant sciences is obtained from the following expression:

$$\ln PS_{it} = -5.38 + .360*\ln CP_{it} + .227*\ln POP_{it} + .619\ln PCY_{it}$$

where PS_{it} = predicted plant science personnel, state $_i$, year $_t$.

CP_{it} = real value of crop production, state $_i$, year $_t$.

POP_{it} = population, state $_i$, year $_t$.

PCY_{it} = per capita real income, state $_i$, year $_t$.

After taking the antilog of the predicted value, the resulting figure is divided into the state's actual value. The ratios are then scaled such that the national average A/P ratio equals 1.00 for the year (1987) for each group. If the A/P ratio exceeds 1.00, the state is allocating more resources to the given area than would have been predicted by its related output, population and per capita income. Conversely, a ratio of less than one signifies a smaller than predicted support.

TABLE 4
NUMBER OF TRE PERSONNEL (#)
AND ACTUAL/PREDICTED (A/P) VALUE (1987)

State	Plant Sci.		Animal Sci.		Ag. Econ.		Home Ec.	
	#	A/P	#	A/P	#	A/P	#	A/P
ME	62	1.01	22	.63	19	1.26	17	.85
NH	35	.87	19	.95	9	.91	6	.39
VT	28	.94	20	1.35	10	.76	9	.55
MA	63	.50	27	.36	15	.66	14	.44
RI	24	.55	8	.35	10	1.21	17	1.25
CT	59	.59	35	.63	13	.63	34	1.24
NY	223	1.00	194	1.27	72	1.35	99	1.60
NJ	78	.48	20	.20	13	.46	20	.54
PA	149	.75	74	.53	49	.97	32	.57
OH	182	.75	185	1.05	51	1.02	70	1.27
IN	175	.83	140	.93	48	1.07	105	2.23
IL	216	.61	192	.73	61	.93	47	.72
MI	154	.73	295	2.01	43	.97	23	.46
WI	174	1.14	115	1.14	43	.88	48	.99
MN	182	.82	144	.94	59	1.14	81	1.64
IA	178	.79	129	.81	50	.94	41	.86
MO	135	.70	117	.88	52	1.17	78	1.68
ND	132	1.16	58	.80	37	1.53	43	1.77
SD	95	1.06	50	.90	26	1.01	4	.16
NE	123	.76	59	.55	28	.64	24	.62
KS	163	.91	115	.97	59	1.29	36	.85
DE	48	.93	27	1.00	14	.92	9	.49
MD	105	.79	47	.58	23	.74	87	2.37
VA	158	1.14	127	1.44	30	.83	74	1.76
WV	70	1.80	32	1.46	14	1.14	1	.05
NC	309	1.56	188	1.34	47	1.05	86	1.79
SC	123	1.20	44	.66	29	1.24	30	1.00
GA	269	1.44	202	1.57	50	1.17	55	1.18
FL	502	1.44	179	.68	58	.96	17	.27
KY	133	1.00	85	.94	43	1.28	23	.61
TN	64	.45	103	1.07	27	.81	36	.93
AL	147	1.28	129	1.68	50	1.54	63	1.69
MS	213	1.89	94	1.22	29	1.06	40	1.27
AR	121	.99	36	.43	32	.97	35	1.00
LA	132	.99	88	.96	38	1.35	48	1.39
OK	127	1.05	102	1.28	36	1.04	69	1.84
TX	461	1.47	329	1.36	54	.72	25	.33

TABLE 4 (continued)
NUMBER OF TRE PERSONNEL (#)
AND ACTUAL/PREDICTED (A/P) VALUE (1987)

State	Plant Sci.		Animal Sci.		Ag. Econ.		Home Ec.	
	#	A/P	#	A/P	#	A/P	#	A/P
(Continued from Previous Page)								
MT	80	.98	64	1.29	20	.98	4	.18
ID	83	.79	58	.86	18	.74	16	.62
WY	41	1.00	37	1.68	12	.84	13	.76
CO	147	.99	207	2.15	41	1.03	41	1.01
NM	77	1.04	37	.81	24	1.12	12	.48
AZ	162	1.08	50	.50	22	.70	25	.70
UT	112	2.09	70	2.21	27	1.58	40	1.78
NV	18	.37	29	1.13	11	.85	17	.96
WA	186	.88	48	.33	32	.79	30	.70
OR	209	1.39	98	.98	31	1.02	59	1.74
CA	674	1.04	228	.43	60	.54	25	.25

TABLE 4 (Continued)
NUMBER OF TRE PERSONNEL (#)
AND ACTUAL/PREDICTED (A/P) VALUE (1987)

State	Other Ag.		Forestry		Other Pers.		Total Pers.	
	#	A/P	#	A/P	#	A/P	#	A/P
ME	16	1.41	77	2.31	38	.91	251	1.21
NH	6	1.00	24	.82	20	.66	119	.83
VT	9	.93	39	2.49	33	.98	148	.87
MA	15	.92	24	.41	62	.82	220	.60
RI	1	.20	19	2.34	9	.35	88	.74
CT	8	.57	8	.18	48	.74	205	.64
NY	76	1.55	209	1.41	244	1.42	1117	1.26
NJ	18	.87	3	.06	120	1.29	272	.59
PA	49	.99	47	.45	79	.52	479	.60
OH	50	1.02	80	1.16	126	.85	744	.97
IN	29	.65	33	.71	130	1.06	660	1.01
IL	31	.46	20	.27	113	.61	680	.68
MI	58	1.40	163	1.73	159	1.21	895	1.31
WI	57	1.15	32	.53	137	1.05	606	.86
MN	42	.80	62	1.07	104	.77	674	.91
IA	63	1.10	12	.59	131	1.02	604	.84
MO	48	1.10	56	1.13	112	.92	598	.93
ND	25	1.12	3	.63	65	1.17	363	1.21
SD	29	1.20	12	1.08	51	.87	267	.85
NE	45	1.00	28	2.35	111	1.10	418	.74
KS	35	.76	21	1.16	145	1.29	574	.93
DE	15	1.36	1	.11	33	.83	147	.73
MD	21	.83	1	.02	85	.92	369	.78
VA	25	.79	59	.63	152	1.42	625	1.13
WV	9	.98	40	1.49	57	1.55	223	1.29
NC	57	1.26	113	1.35	160	1.29	960	1.47
SC	35	1.72	55	1.14	43	.64	359	1.07
GA	56	1.35	66	.73	146	1.21	844	1.33
FL	44	.71	50	.51	114	.65	964	1.03
KY	39	1.20	19	.47	71	.79	413	.88
TN	19	.61	33	.62	82	.87	364	.75
AL	48	1.54	42	.80	143	1.60	622	1.35
MS	35	1.32	47	1.26	169	2.36	627	1.72
AR	24	.73	27	.67	49	.59	324	.74
LA	21	.81	45	.83	116	1.45	488	1.21
OK	32	.95	17	.77	53	.57	436	.91
TX	87	1.03	27	.25	202	.94	1185	1.02

TABLE 4 (Continued)
NUMBER OF TRE PERSONNEL (#)
AND ACTUAL/PREDICTED (A/P) VALUE (1987)

State	Other Ag.		Forestry		Other Pers.		Total Pers.	
	#	A/P	#	A/P	#	A/P	#	A/P
(Continued from previous page)								
MT	17	.95	34	1.08	53	1.07	272	1.06
ID	23	1.02	153	3.99	26	.45	377	1.23
WY	9	.79	1	.06	36	1.02	149	.83
CO	24	.64	47	.70	68	.65	575	1.03
NM	11	.59	8	.33	26	.47	195	.69
AZ	56	1.99	30	.65	97	1.12	442	.99
UT	24	1.71	39	1.92	124	2.63	436	1.88
NV	7	.80	22	1.85	22	.60	126	.70
WA	31	.82	127	.90	57	.51	511	.86
OR	28	1.02	190	1.83	114	1.39	729	1.71
CA	30	.24	71	.20	307	.95	1395	.78

As expected, the largest states allocate the largest absolute amount of resources to the production of TRE services. However, after taking into account population, per capita income and related output, their propensity to support TRE activities varies considerably across state and across areas, as indicated by the variability of the A/P ratios among and within the states.

The propensity to support TRE activities of the experiment stations as given by the A/P ratios does not appear to be related to the size or wealth of the state. For example, states in the midwest where agriculture is an important part of their GDPs do not appear to be more generous in their support of experiment stations as reflected by their A/P ratios than states in the South or West. Many southern and western states have A/P ratios greater than 1.00. Utah exhibits the highest propensity to support its experiment station. The highly urbanized states in the northeast, for the most part, have A/P ratios less than one. California, in spite of having the largest experiment station network in the country, 1395 professionals, exhibits an A/P ratio for total personnel of .78, considerably below the national average ratio of 1.00.

This is not to say that all states can or should converge to a 1.00 A/P ratio. If there are diminishing returns to TRE activities, a large state such as California having ten times the resources of another state may not find it profitable to have an experiment station network ten times as large. On the other hand, Texas and New York, having the second and third largest systems, exhibit A/P ratios greater than one. At any rate, a state exhibiting a relatively small A/P ratio can be expected to enjoy a relatively high rate of return to investment in TRE activities, suggesting it should invest more in these areas. Finally, it should be pointed out that a 1.00 ratio across states does not necessarily imply an optimal level of investment in TRE. If the expected rate of return to investment in TRE activities exceeds the national average marginal rate of return on other investment, estimated to be about 15 percent (Peterson, 1989), there would still be underinvestment in these activities, and vice versa.

Concluding Remarks

The evidence suggests that the propensity to support teaching, research and extension activities of the agricultural experiment stations and cooperating institutions has not declined during the 1980s. From these results one might predict continued, long run growth in demand for the services of experiment stations. However this does not necessarily guarantee that in the long run, these institutions will remain unchanged or even viable. Institutional changes could result in a shifting of these activities to other units such as the biological, physical or social sciences, or to new institutions not yet on the "drawing boards". Survival of the administrative units within experiment stations and of the stations themselves would seem to depend on their ability to adapt to the changing demands of society. Forestry, with its expanded focus on natural resources and the environment, appears to have been the most successful in this regard.

REFERENCES

Bredahl, Maury and Willis Peterson, "The Productivity and Allocation of Research: U.S. Agricultural Experiment Stations". American Journal of Agricultural Economics 54:684-692, February 1969.

Evenson, Robert and Susan Rose-Ackerman, "The Political Economy of Agricultural Research and Extension Grants, Votes and Reapportionment", American Journal of Agricultural Economics, February 1985.

Friedman, Milton, Price Theory, Chicago: Aldine Publishing Company, 1962.

Griliches, Zvi, "Research Costs and Social Returns; Hybrid Corn and Related Innovations", Journal of Political Economics 66:419-431, Oct. 1958.

Guttman, Joel. "Interest Groups and the Demand for Agricultural Research", Journal of Political Economics 86:467, June 1978.

Huffman, Wallace E. and John A. Miranowski, "An Economic Analysis of Expenditures on Agricultural Experiment Station Research", American Journal of Agricultural Economics 63:104-18, February 1981.

Pardey, Philip G., M. Sandra Kang, and Howard Elliott, "The Structure of Public Support for National agricultural Research Systems: A Political Economy Perspective," Agricultural Economics, forthcoming.

Peterson, Willis L., "The Allocation of Research, Teaching and Extension Personnel in U.S. Colleges of Agriculture", American Journal of Agricultural Economics 51:41-56, February 1969.

________, "Rates of Return on Capital: An International Comparison", Kyklos 42:203-217. February 1989.

U.S. Department of Agriculture, Professional Workers in State Agricultural Experiment Stations. Agricultural Handbook Series, 1950-1987, inclusive.

FOOTNOTES

*Professor, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul.

[1]To economize on verbiage, the colleges will henceforth be included under the generic title, "agricultural experiment station". It is recognized that in many states, these traditional names have been broadened to convey a wider mission than existed in earlier times. Again, to simplify the terminology, the new names also will be included under the umbrella.

[2]Because the national average A/P ratio is set equal to 1.00, the constant term has no bearing on the results.