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The Allocation of Research Personnel:
Administrators' Response to
Expected Rates to Return

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Introduction

Bredahl and Peterson (1976) provided estimates of marginal products by states for the commodity groups cash grains, dairy, poultry and other livestock research in the United States using 1969 Census of Agriculture data. Their results showed national rates of return to crop and livestock research to be in the 36 to 46% range. Agricultural researchers and administrators have used these estimates in support of budget requests. It is the intent of this paper to find whether or not these economic indicators have also resulted in any adjustments with regards to the number of personnel employed at respective research institutions. The hypothesis being that states which have experienced high marginal products to research for a specific commodity group will allocate research funds to expand the size of departments where the returns to research are the greatest. Similarly, states which have experienced low marginal products to research on specific commodities will reallocate research funds away from those research departments.

The Data

The data to determine the adjustments made by states on departments involved in research activities regarding the four broad commodity groups mentioned earlier was taken from the annual U.S.D.A. publication, "Professional Workers in State Agricultural Experiment Stations and Other Cooperating State Institutions" (69-70, 80-81). Data from the same publication was used by Peterson (1969) to inventory the allocation of research, teaching, and extension personnel by departments in U.S. colleges of agriculture and state agricultural experiment stations. However, tabulation of this data was approached somewhat differently due to the increased difficulty in later publications of differentiating individuals by their field of specialization

and also by their respective duties within that field. Therefore, there was no attempt made to separate extension activities from teaching and research activities. Although in cases where departments have merged, former publications were consulted to provide consistency with regards to individuals' fields of specialization. A simple head count was taken of department personnel and included only faculty of the rank instructor or research associate and higher. Supporting staff, graduate and undergraduate students were excluded from the tally. In cases where disciplines were merged within a single department and there was no other way to discriminate an individual's field of specialization, each discipline within that department would be given a fraction to account for him/her. For example, in cases where poultry, dairy and livestock were all included within a single department called Animal Science, a professor of genetics would be accounted for as one third of a person to each of the three disciplines. Departments of Agronomy were used to measure adjustments made to cash grain research. Although in cases where departments of Soil Science had merged with Agronomy, an effort was made to differentiate specialties on an individual basis, thereby providing consistency throughout. Differences in department sizes were calculated in both percentage and absolute terms over the eleven year, 1969-1980 period. These figures provided the dependent variables. Independent variables, the marginal products to research by state, by commodities, came directly from Bredahl and Peterson's article, "The Productivity and Allocation of Research: U.S. Agricultural Experiment Stations" (1976) where marginal products are used as proxies for rates of return. The numbers of personnel and their respective marginal products of research are presented in Table 4.

Regression Results:

Simple regressions were performed to determine if allocative adjustments were made during the eleven year period following 1969 which was the year in which Census of Agriculture data was used to calculate marginal products to research by Bredahl and Peterson (1976). The results of these regressions are provided in Table 1. Both percentage and absolute changes in numbers of experiment station personnel are presented as dependent variables, although I feel the absolute change variable provides a more accurate account of adjustments because in many cases departments are small and the loss or gain of a single employee results in a huge percentage change and is better explained in absolute terms. The results show that only the commodities poultry and cash grain have a direct causal relationship between the marginal products to research in these fields and the adjustments made by experiment stations involved in research on them. In these two fields outliers were omitted to determine the best fit of the regression line. In the case of poultry the best fit occurs with the exclusion of Mississippi's data which showed a high marginal product to poultry research but a large decrease in the number of personnel involved in poultry research. Outliers in the regressions with cash grain were Texas and Illinois. Texas had a high marginal product to research but it's doubtful that the huge increase in the number of personnel involved in cash grain research is due solely to this high marginal product. I suspect increases of this type in Texas are due to the oil revenue and influx of business to that state allowing them to expand their research stations. On the other hand, Mississippi is a revenue deficient state and probably cannot afford to even maintain its present facilities even though they offer high returns. Illinois' marginal product to cash grain research was the highest by far of any state but their increase in personnel involved in cash grain research was quite modest;

therefore, exclusion of the Illinois data resulted in the best fit of the regression line. Regressions performed on Dairy and Livestock individually showed no causal relationship between their marginal products to research and any changes in their personnel numbers. Dairy and livestock were often merged under the same department title and it was often difficult to discern the activities of individuals. In order to alleviate this problem the data for dairy and livestock were combined and regressed against a weighted value for their combined marginal products to research (see Table 2). The results of this regression were also insignificant leading one to conclude that administrators of experiment stations involved in dairy and livestock research do not take marginal products or rates of return to research into account when adjusting the size of their departments. Poultry was then combined in similar fashion to dairy and livestock but again the regression results were insignificant. Finally, adjustments made in all four commodity groups were combined and regressed against a combined, weighted marginal product to research on all four commodities. The results of this regression were significant with Texas and Minnesota outliers. The best fit of the regression line occurred when Minnesota, with its extremely high combined marginal product to research and modest personnel growth, was omitted.

The regression results presented in Tables 1 and 2 represent adjustments made between states to their respective commodities' marginal products of research. To measure the adjustments made within states, individual regressions were performed on all 48 states using the absolute changes within each of the four commodity groups in each state as the dependent variables. The results of these regressions are presented in Table 3. Although the number of observations is small (4 in most states), each observation represents an aggregate adjustment made within a specialized field of research. Therefore, the small

sample size and few degrees of freedom are no cause for alarm except in the cases of Vermont, Massachusetts and Rhode Island. In Vermont's case there were no adjustments made during the entire eleven year, 1969-80 period. This resulted in a perfectly fitted, horizontal regression line. In the cases of Massachusetts and Rhode Island there were observations available for only poultry and dairy research. As a result there were zero degrees of freedom and again perfectly fitted regression lines connected the two points. Results from the remaining states are insignificant except for New Hampshire with a positive coefficient of .29 reliable at the .025 significance level and New Mexico with a positive coefficient of .49 reliable at the .05 significance level.

Conclusions:

The results of this analysis would lead one to conclude that, generally speaking, marginal products or rates of return to research, are not taken into consideration by administrators of experiment stations when deciding on how and whether or not to adjust the numbers of personnel involved in specific research areas at these stations. Although New Hampshire and New Mexico do appear to make positive adjustments with higher rates of return to their research activities, coincidence cannot be ruled out in these two instances. Aggregated results pointed to a direct causal relationship between the expected economic payoff and the respective adjustments made to the areas of poultry and cash grain research; whereas there were no adjustments made in the areas of livestock and dairy research. These are somewhat mysterious findings in that one would expect similar behavior between the disciplines of poultry and dairy research due to the fact that they are both quite specific in nature. Let it suffice to say that there are many factors involved in decisions with regards to personnel allocation among research fields; and some of these factors are obviously considered more important than economic payoff when it comes to research funds allocation.

Differential rates of return on alternative investments between states could explain at least some of the between state variation rates of return to research. For example, Mississippi had a high marginal product to poultry research, but experienced a drastic reduction in the number of research personnel involved in poultry research during this period. It is possible that during this period alternative investments in such things as road construction, harbor development, etc. showed a higher return to investment and were thus selected for greater amounts of state funding. Likewise, in Texas, where the returns to research were not particularly high and the number of research personnel increased dramatically, it is possible that alternative uses for this states revenues have a lower economic payoff than research, resulting in a higher appropriation of funds to research. Investigation into the economic returns of alternative investments by the governments of these states would be interesting and possibly quite revealing. Of course even if such interstate differences in rates of returns to research can be rationalized for short run periods, it does not explain or justify the large differences in rates of return that exist within states between the four commodity groups.

Table 1. Between State Adjustments to Marginal Products of Research.

Change in Number of Experiment Station Personnel 69-80 (Dependent Variable)	Poultry			Cash Grain			Dairy			Livestock		
	Constant	Coeff.	R^2	Constant	Coeff.	R^2	Constant	Coeff.	R^2	Constant	Coeff.	R^2
Percentage Change	-18.86	1.22 (3.74)*	.2331	11.59	1.41 (2.59)	.1471	2.19	.047 (.13)	.0004	17.7	.232 (.91)	.0184
Absolute Change	-1.41	.11 (3.67)	.2261	2.37	.994 (3.18)	.2057	.039	.00005 (.00)	.00	2.7	.084 (1.43)	.0442
Absolute Change (Excluding Georgia & Mississippi	-1.41	.104 (4.66)	.3303									
Absolute Change (Excluding Georgia)	-1.21	.076 (3.13)	.1792									
Absolute Change (Excluding Mississippi)	-1.62	.14 (4.93)	.3511									
Absolute Change (Excluding Texas & Illinois)				2.74	.741 (3.05)	.2014						
Absolute Change (Excluding Texas)				3.69	.592 (3.53)	.2475						
Absolute Change (Excluding Illinois)				-1.33	1.56 (3.71)	.2654						

* Values in parentheses are "t" ratios.

Table 2. Regressions of Weighted Marginal Products of Research on Combined Adjustments, Between States.

Change in Number of Experiment Station Personnel 69-80 (Dependent Variable)	Dairy & Livestock			Dairy, Livestock & Poultry			Dairy, Livestock Poultry & Cash Grain		
	Constant	Coeff.	R^2	Constant	Coeff.	R^2	Constant	Coeff.	R^2
Absolute Change	2.00	.065 (1.18)	.0295	-.169	.094 (1.62)	.054	-3.57	.322 (3.29)	.1901
Absolute Change (Excluding Texas & Minnesota)							-.063	.217 (3.2)	.1889
Absolute Change (Excluding Texas)							2.3	.163 (2.75)	.1442
Absolute Change (Excluding Minnesota)							-8.2	.427 (3.93)	.2552

Table 3. Within State Adjustments to Marginal Products of Research

	Constant	Coeff.	R^2	No. of Observations
Maine	1.5	-.07 (-.4)	.1403	3
New Hampshire	-2.94	.29 (25.07)	.9984	3
Vermont[1]	0	0 (n.a.)	1.0	3
Massachusetts[1]	-1.7	0 (n.a.)	1.0	2
Rhode Island[1]	-3.01	.48 (n.a.)	1.0	2
Connecticut	-1.96	-.18 (-1.18)	.5819	3
New York	.34	-.19 (-1.61)	.5653	4
New Jersey	-5.05	.5 (1.83)	.6272	4
Pennsylvania	5.31	-.76 (-2.55)	.7645	4
Ohio	-2.27	.75 (.44)	.0865	4
Indiana	11.68	-.42 (-.63)	.164	4
Illinois	-8.84	.55	.5492	4
Michigan	-21.88	2.4 (2.08)	.6831	4
Wisconsin	3.0	-.012 (-.29)	.0408	4
Minnesota	3.89	-.022 (-.25)	.0312	4
Iowa	-5.01	.021 (.23)	.025	4
Missouri	4.59	.086 (.29)	.0416	4
North Dakota	3.02	.075 (.15)	.0116	4
South Dakota	3.09	.043 (.15)	.0106	4
Nebraska	1.45	-.032 (-.07)	.0027	4
Kansas	3.6	.23 (1.38)	.4877	4
Delaware	2.13	-.059 (-.52)	.1205	4
Maryland	2.46	.005 (.02)	.0001	4
Virginia	-3.64	.396 (.74)	.2163	4

Table 3. continued

	Constant	Coeff.	R^2	No. of Observations
West Virginia	15.1	-1.34 (-4.14)	.8956	4
North Carolina	9.51	-.15 (-.42)	.0814	4
South Carolina	3.37	.098 (.38)	.0686	4
Georgia	5.68	.22 (1.38)	.4862	4
Florida	9.85	-.41 (-1.04)	.3512	4
Kentucky	3.19	.069 (.22)	.0228	4
Tennessee	4.09	-.34 (-.42)	.082	4
Alabama	.98	.076 (1.5)	.5303	4
Mississippi	8.03	-.31 (-2.37)	.7381	4
Arkansas	11.65	-.055 (0.21)	.0208	4
Louisiana	2.57	.207 (.19)	.0178	4
Oklahoma	1.86	.008 (.02)	.0003	4
Texas	57.69	-.76 (-.28)	.0369	4
Montana	-1.68	.41 (.98)	.2998	4
Idaho	10.48	-.21 (-.35)	.0565	4
Wyoming	-1.16	.35 (2.98)	.8159	4
Colorado	10.4	-.19 (-.58)	.1447	4
New Mexico	-3.03	.49 (4.26)	.9007	4
Arizona	4.94	-.61 (-1.3)	.4595	4
Utah	3.59	.198 (.61)	.1553	4
Nevada	-1.21	.25 (3.46)	.9231	3
Washington	-.608	.18 (.13)	.0088	4
Oregon	-10.62	1.61 (1.52)	.5359	4
California	15.24	-.53 (-2.34)	.7317	4

[1] Regressions made from observations on Vermont, Massachusetts and Rhode Island lacked t-statistics and show dubious results due to the small sample size (2 observations for Massachusetts and Rhode Island) and the absence of any response on the part of Vermont.

Table 4. Number of Research, Teaching and Extension Personnel by State and Departments, and Marginal Products of Research, by State.

	POULTRY					CASH GRAIN					DAIRY					LIVESTOCK				
	No. of Experiment Station Personnel		Absolute	Percent		No. of Experiment Station Personnel		Absolute	Percent		No. of Experiment Station Personnel		Absolute	Percent		No. of Experiment Station Personnel		Absolute	Percent	
	69-70	80-81	Change	Change	MPR[2]	69-70	80-81	Change	Change	MPR[2]	69-70	80-81	Change	Change	MPR[2]	69-70	80-81	Change	Change	MPR[2]
Maine	11	10.3	-.7	-6.4	26.97	n.a.[1]	n.a.	n.a.	n.a.	n.a.	4	7.3	3.3	82.5	7.21	5	4.3	-.7	-14	3.72
New Hampshire	6.7	4.7	-2	-29.8	3.40	n.a.	n.a.	n.a.	n.a.	n.a.	5.7	5.7	0	0	9.80	5.7	7.7	2	35.1	17.15
Vermont	3	3	0	0	2.36	n.a.	n.a.	n.a.	n.a.	n.a.	5	5	0	0	39.08	5	5	0	0	2.04
Massachusetts	10.7	8	-1.7	-15.9	4.82	n.a.	n.a.	n.a.	n.a.	n.a.	6.7	5	-1.7	-25.4	14.73	n.a.	n.a.	n.a.	n.a.	n.a.
Rhode Island	3.7	1.3	-2.4	-64.9	1.26	n.a.	n.a.	n.a.	n.a.	n.a.	3.7	1.8	-1.9	-51.3	2.29	n.a.	n.a.	n.a.	n.a.	n.a.
Connecticut	7	4	-3	-42.9	13.07	n.a.	n.a.	n.a.	n.a.	n.a.	13	7	-6	-46.1	18.12	12	9	-3	-25	3.39
New York	14	10	-4	-28.6	10.21	43	46	3	6.98	1.07	22	17	-5	-22.7	33.23	22	20	-2	-9.1	5.61
New Jersey	5	3.5	-1.5	-30	4.18	28	23	-5	-17.9	1.87	6	4.5	-1.5	-25	8.22	12	8.5	-3.5	-29.2	3.33
Pennsylvania	11	9	-2	-18.2	12.26	37	45	7	18.9	3.64	31	16.5	-14.5	-46.8	24.79	21	18.5	-2.5	-11.9	3.05
Ohio	15	15	0	0	9.40	52	68	16	30.8	12.52	20	22	2	10	15.96	32	45	13	40.6	15.85
Indiana	19.3	17.3	-2	-10.4	19.01	58	75	17	29.3	14.60	17.3	17.3	0	0	12.64	23.3	22.3	-1	-4.3	32.12
Illinois	12	11	-1	-8.3	12.63	86	109	23	26.7	40.14	24	20	-4	-16.7	9.19	34	36	2	5.9	38.49
Michigan	10	12	2	20	8.10	49	41	-8	-16.3	7.32	23	27	4	17.4	11.48	19	25	6	31.6	11.28
Wisconsin	6	8	2	33.3	8.41	22	24	2	9.1	2.65	20	22	2	10	56.00	17	22	5	29.4	12.50
Minnesota	7.7	6.7	-1	-13	18.20	33	41	8	24.2	13.15	15.7	17.7	2	12.7	51.11	15.7	18.7	3	19.1	75.55
Iowa	9	7	-2	-22.2	11.19	82	73	-9	-11	10.62	20	17	-3	-15	16.57	35	31	-4	-11.4	60.13
Missouri	9	8	-1	-11.1	14.12	47	65	18	38.3	12.30	13	13	0	0	8.42	20	29	9	45	53.24
North Dakota	6.3	3.3	-3	-47.6	2.79	27	46	19	70.4	18.42	9.8	10.8	1	10.2	20.27	11.8	12.8	1	8.5	37.24
South Dakota	6	4	-2	-33.3	4.18	44	56	12	27.3	6.85	9	9	0	0	13.31	22	27	5	22.7	37.11
Nebraska	7	3	-4	-57.1	2.26	55	67	12	21.8	9.45	9	7.7	-1.3	-14.4	4.00	26	23.7	-2.3	-8.8	28.06
Kansas	4.5	6	1.5	33.3	2.55	55	69	14	25.4	11.25	12.5	13.5	1	8	6.70	26	40.5	14.5	55.8	52.39
Delaware	7	8	1	14.3	16.74	17	20	3	17.6	4.21	5	5.5	.5	10	2.37	4	6.5	2.5	62.5	2.14
Maryland	9	11	2	22.2	13.54	27	31	4	14.8	5.00	11	15	4	36.4	8.35	8	8	0	0	5.20
Virginia	15	14	-1	-6.7	8.91	39	37	-2	-5.1	2.57	15	19	4	26.7	10.69	26	23	-3	-11.5	9.58
West Virginia	5.7	5.7	0	0	8.25	45	61	16	35.6	0.48	9.7	5.7	-4	-41.2	14.24	19.7	19.7	0	0	13.08
North Carolina	19	24	5	26.3	38.71	49	68	19	38.8	3.81	20	19.5	-.5	-2.5	6.46	26	31.5	5.5	21.1	12.10
South Carolina	8	14	6	75	18.06	19	25	6	31.6	3.84	13	14	1	7.7	7.73	12	16	4	33.3	6.11
Georgia	14	28	14	100	36.65	34	44	10	29.4	1.92	12.5	14.7	2.2	17.6	5.33	12.5	21.7	9.2	73.6	14.02
Florida	9	10	1	11.1	25.22	25	42	17	68	1.52	13	13	0	0	6.57	25	32	7	28	1.66
Kentucky	6.3	7.3	1	15.9	8.19	65	71	6	9.2	6.20	12.3	15.3	3	24.4	15.76	28.3	34.3	6	21.2	16.88
Tennessee	7	5.3	-1.7	-24.3	17.29	41	49	8	19.5	5.74	19	12.3	-6.7	-35.3	6.33	27	31.3	4.3	15.9	7.23
Alabama	10	15	5	50	48.26	40	43	3	7.5	2.06	7	8	1	14.3	6.14	25	25	0	0	10.39
Mississippi	23	18	-5	-21.7	41.01	45	52	7	15.6	8.62	11	12	1	9.1	10.18	13	19	6	46.1	14.43
Arkansas	9.3	13.7	4.4	47.3	66.40	34	59	25	73.5	19.83	9.3	9.7	.4	4.3	4.29	15.3	26.7	11.4	74.5	8.48
Louisiana	11	11	0	0	6.56	28	36	8	28.6	7.04	18	18	0	0	2.58	15	21	6	40	1.88
Oklahoma	4.7	4	-.7	-14.9	10.94	40	47	7	17.5	7.40	6.7	5	-1.7	-25.4	10.51	20.7	24	3.3	15.9	24.26
Texas	20	20	0	0	21.05	77	173	96	124.7	18.91	15.5	23.5	8	51.6	30.11	32.5	73.5	41	126.1	43.26
Montana	1.3	1.7	.4	30.8	2.82	35	34	-1	-2.9	13.56	2.8	3.7	.9	32.1	6.71	18.8	27.7	8.9	47.3	15.65
Idaho	2	3	1	50	3.38	48	68	20	41.7	6.77	6	11	5	83.3	23.31	13	18	5	38.5	19.56
Wyoming	2.3	1	-1.3	-56.5	0.82	10	9	-1	-10	2.36	3.3	4	.7	21.2	2.31	13.3	16	2.7	20.3	11.21
Colorado	9	6.7	-2.3	-25.6	9.73	41	63	22	53.7	16.73	6.5	4.2	-2.3	-35.4	41.45	20.5	20.2	-.3	-1.5	61.97
New Mexico	3	2.7	-.3	-10	3.81	21	22	1	4.8	6.52	4	5.7	1.7	42.5	15.26	19	31.7	12.7	66.8	29.37
Arizona	4	3	-1	-25	5.23	57	63	6	10.5	2.14	7	6	-1	-14.3	7.38	11	11	0	0	11.01
Utah	10	12.3	2.3	23	9.70	24	29	5	20.8	2.12	12	17.3	5.3	44.2	7.38	21	29.3	8.3	39.5	13.80
Nevada	2.3	1.7	-.6	-26.1	1.43	n.a.	n.a.	n.a.	n.a.	n.a.	3.3	2.7	-.6	-18.2	3.93	6.3	7.7	1.4	22.2	10.18
Washington	7	5.3	-1.7	-24.3	4.42	53	62	9	17	9.88	11	6.3	-4.7	-42.7	11.52	18	19.3	1.3	7.2	9.10
Oregon	3	3.3	.3	10	9.28	34	30	-4	-11.8	4.60	5	7.3	2.3	46	7.29	12	19.3	7.3	60.8	8.94
California	12	14	2	16.7	19.32	39	51	12	30.8	6.17	10.5	16.5	6	57.1	20.48	18.5	25.5	7	37.8	18.22

[1] Estimates of marginal products were not calculated. Thus cases denoted by (n.a.) were not included in the sample.

[2] Marginal Products of Research are reprinted from article by Bredahl and Peterson (1976).

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