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Is the Demand for Agricultural Experiment Station Personnel Declining?

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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 suggest that the TRE staffing during the 1950s and 1960s was smaller than predicted but that the catching up process was in large part completed during the 1970s. Although there is no sign of an unexplained decrease in TRE demand during the 1980s, prospects of zero growth during the 1990s implies a substantial reduction in replacement demand for new Ph.Ds compared to earlier times. Zero growth has implications for the design of Ph.D programs since the majority of future graduates will find employment outside of experiment stations and associated colleges.

Because of the depressed state of agriculture during the 1980s and declining enrollments in colleges of agriculture, the question arises: what does the future hold in store for agricultural experiment stations and associated institutions: colleges of agriculture, forestry, home economics and veterinary medicine?[1] Will personnel numbers stabilize in the foreseeable future, will they resume an upward trend, or will they begin a long term decline?

In an attempt to answer this question, the first objective of this paper is to inventory the stock of (TRE) teaching, research, and extension personnel and compare it to the stocks that existed at earlier points in time. A second objective is to estimate the demand for experiment station personnel and to determine if it has changed over time. In the last section, prospects for growth or decline are assessed, and implications are drawn.

Overview

In order to obtain information on the allocation of effort within experiment stations by administrative units, TRE personnel numbers are utilized. The data are easily accessible from a published source (U.S. Department of Agriculture). Data from seven administrative units, some are departmental groupings, are presented. The degree of confidence one can place in the accuracy of the numbers should be relatively high. They are simply name counts of departmental staff.

To maintain consistency among observations, the personnel numbers include only professional staff having an academic or station appointment.[2] Because of inadequate information on the exact allocation of time of professional staff among teaching, research, extension, and administrative functions, a functional separation among these activities is not attempted.

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

1. Plant sciences. This category includes the departments of agronomy, horticulture, landscape architecture, plant pathology, entomology, and soils.[3]
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 natural 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.
7. Other personnel. By and large, this group includes administrative personnel at the experiment station and college levels, including extension administration.

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

The seven groups include 100 percent of the 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. However, 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. 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 (including fisheries, wildlife, and the environmental services) 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. 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 personnel is not necessarily a good indication of change in specific units. By the same token, growth or decline of a discipline does not imply the same thing for all departments in that discipline. However chances for growth of a department are likely to be greater if the discipline is growing than if it is not.

Demand Functions

Several studies have attempted to identify and measure the factors affecting experiment station support (Peterson; Guttman; Huffman and Miranowski; Evenson and Rose-Ackerman; Pardey, Kang and Elliott).[4] By and large, these studies, at least the more recent ones, utilized a number of demographic, political and institutional factors as explanatory variables. A simpler model is utilized here; one that focuses on a small number of economic and demographic variables. Although political and institutional factors may influence experiment station support in the short run, a state's long run financial support ultimately depends on its underlying economic and demographic base. Also with one exception, the previous studies focused on total expenditures of the stations rather than on specific administrative units.

Because the data are made up primarily of cross section observations, it is not feasible to include a price (salary) variable. In a competitive labor market, real, quality adjusted salaries should equalize among departments, particularly in a given discipline. Granted at a point in time nominal differences may exist because of short run disequilibria or because of differences in faculty quality, living costs, or amenities specific to an area. It is assumed here that the labor market is working and that real quality adjusted wages are equal among units of a given discipline at a point in time.

The main interest is in the demand shifters and the intercept dummies. A significant coefficient on an intercept dummy is an indication of an unexplained shift in the demand function. The demand shifters include 1) related output, 2) rural population, and 3) per capita income. Other things equal, the greater the related output, the higher the expected rate of return to a given TRE investment (Griliches). Population is a measure of market size, while per capita income reflects a state's ability to generate tax revenue. Initially population was divided into two groups: urban and rural. For the most part, urban population was not significant and therefore was deleted from the equation.

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 values. All monetary values are deflated by the CPI, 1987 = 100.

Related output for the plant and animal sciences is real (CPI deflated) value of crop and livestock production respectively. 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 these units go beyond agriculture but no good proxy for the rate of return on investment in these services exist. 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 value of lumber over time. The stock of standing timber was utilized as value of related output rather than lumber sales because much forestry and environmental sciences work deals with forest and resource management, which goes beyond timber harvesting.

Demand Elasticities

The results of demand estimation are presented in Table 2. All the coefficients on related output and rural population are positive and highly significant. The mixed results on per capita income are somewhat unexpected, especially the negative but insignificant coefficient for agricultural economics.

In general the results support the intuitive notion that states with larger agricultural resource bases and larger rural populations have larger experiment stations. And the make-up of experiment station personnel particularly between the crop and animal sciences depends to a large degree on the relative size of the two related industries. Moreover as change occurs over time in the value of agricultural output, corresponding changes occur in the size and staffing of experiment stations. The results also are consistent with economic logic. For a given level of TRE activities, the greater the value of related output, the higher the expected rate of return to these activities, and the greater the incentive to invest until the rate of return equalizes with other investment. By the same token, as changes occur in real value of agriculture output, the optimal level of investment changes in the same direction. Prices have the same influence as quantity in determining expected rates of return.

The intercept dummies are presented separately in Table 3. The year 1970 is the reference year. With a couple of exceptions, the coefficients for 1950 and 1960 are negative and highly significant. This implies that the actual numbers of TRE personnel in the 1950s and 1960s were smaller than predicted by the equations. A possible

TABLE 2

Demand Elasticities*

	Related Output	Rural Population	Per Capita Income	R^2
Animal Sciences	.400 (14.6)	.296 (8.81)	.173 (1.85)	.802
Plant Sciences	.357 (14.9)	.229 (6.55)	.414 (4.70)	.820
Ag. Economics	.323 (13.5)	.240 (8.06)	-.015 (-.190)	.813
Other Ag.	.407 (14.7)	.317 (9.19)	-.121 (1.36)	.817
Forestry	.284 (6.12)	.553 (6.99)	.458 (1.80)	.566
Home Ec.	.177 (3.20)	.309 (4.50)	.597 (3.38)	.329
Other Personnel	.258 (7.71)	.318 (7.64)	.316 (2.94)	.682
Total Personnel	.301 (14.7)	.306 (12.0)	.285 (4.36)	.870

*Figures in parentheses are t-ratios.

TABLE 3

Intercept Dummies*

	1950	1960	1980	1987
Animal Sciences	-.608 (7.12)	-.215 (2.71)	.063 (.840)	.091 (1.14)
Plant Sciences	-.536 (6.65)	-.235 (3.14)	-.054 (.754)	-.010 (.134)
Ag. Economics	-.731 (10.4)	-.309 (4.74)	-.005 (.087)	.015 (.238)
Other Ag.	-.492 (6.07)	-.169 (2.25)	.051 (.704)	.134 (1.78)
Forestry	-.963 (4.16)	-.734 (3.43)	.289 (1.41)	.310 (1.46)
Home Ec.	.132 (.819)	.267 (1.78)	.060 (.418)	-.115 (.770)
Other Personnel	-.250 (.255)	-.020 (.218)	.187 (2.16)	.212 (2.34)
Total Personnel	-.478 (7.99)	-.184 (3.32)	.073 (1.38)	.092 (1.67)

*Figures in parentheses are absolute values of the t-ratios.

explanation is that the unusual circumstances of the preceding two decades--the Great Depression and World War II--dampened the growth that would have taken place in normal times. The rapid growth that occurred during the 1950s and 1960s might be viewed as a catching up phenomenon. The statistically insignificant coefficients on most of the intercept dummies for 1980 and 1987 suggest that the adjustment for the most part was completed during the 1970s. Also after taking into account the three demand shifters, no unexplained decrease in demand for TRE personnel is evident for the 1980s. However in one area, other personnel (administration), the positive and significant 1980 and 1987 dummies imply that a number of administrative personnel in the 1970s and 1980s exceeded those predicted by the independent variables.

Future Prospects

The number of TRE personnel employed by experiment stations reached a plateau during the 1980s. The question now is whether the numbers will stabilize at current levels, resume an upward trend, or begin a long run decline? The demand functions presented in the preceding section might be of some help to predict future changes. Assuming for the moment that the functions are accurately specified and that the elasticities do not change in the future, changes in the two main independent variables--related output and rural population--will determine the future values of the dependent variables. To test for possible changes in the elasticities of the demand shifters, the model was estimated with slope dummies on the three shift variables for 1987. With one exception, none of the slope dummies was statistically significant. The single exception was a negative and marginally significant coefficient for per capita income in the plant sciences equation. But for the most part there is no strong evidence to suggest that the elasticities are declining over time.

A perspective on likely future changes in the demand shifters might be gained from their past trends. As shown in Table 4, real (CPI deflated) agriculture output, crops and livestock, declined substantially during the 1980s. This trend, of course, was not conducive to growth of TRE personnel. In fact, the decline in personnel numbers during the 1980s, where it occurred, is not surprising. However, if the depressed state of agriculture during the 1980s is an aberration, a return of more favorable conditions in the 1990s and beyond will increase real value of output and ease pressure for decline. Much depends on agricultural exports. It is hard to envision 1990s exports and real (CPI adjusted) value of agricultural output exceeding the late 1970 levels, the era of the cheap dollar. Therefore about the best that can be envisioned for the 1990s is for relatively stable TRE numbers.

The relative stability of TRE numbers in the foreseeable future has important implications for the academic labor market. Because of the rapid growth of TRE personnel during the 1950s and 1960s, the market was able to accommodate the increase in number of Ph.Ds coming out of the programs during this time. However for the most part annual Ph.D output has not declined in recent years even though there has been a decrease in demand for new entrants into the professions. Even if the demand for total personnel remains relatively constant, the demand for new Ph.Ds to replace those leaving the professions, of course, will be much smaller than when total TRE numbers were growing.

TABLE 4

U.S. Agricultural Output and Rural Population
Selected Years

	*Real Output ($ bil)			Rural
	Livestock	Crops	Total	Population (mil)
1950	66.8	51.5	118.3	54.2
1960	63.9	51.3	115.2	54.1
1970	76.0	54.1	130.1	53.9
1980	83.5	87.0	170.5	59.5
1987	54.5	67.1	121.6	64.1

*Deflated by CPI, 1982-84 = 100

A little simple arithmetic illustrates the magnitude of the problem. With stable numbers, the number of new entrants into a profession is limited to the number who leave. Taking 25 years as the average length of academic career, a faculty member needs to turn out just one new Ph.D every 25 years to maintain stable numbers. However it is not uncommon for a faculty to turn out one or more each year. If the market were limited to academic TRE positions, 24 out of the 25 would not be able to find jobs in their field. It is not surprising that a single TRE job opening can attract up to 100 applicants. Nor is it surprising that this excess supply has depressed real salaries in academia. Of course the situation is not quite this bleak. Not all personnel or academic departments produce new Ph.Ds, and nonacademic jobs in government and industry exist. Also some graduates find teaching positions in nonagricultural colleges. An important growth area now for the agricultural Ph.Ds is in the foreign job market. To maintain full employment of TRE personnel, at least in graduate student training, graduate programs will have to enroll a substantial proportion of students from developing countries. And a greater proportion of domestic graduates will have to find employment outside of experiment stations in the U.S. or in developing countries.

The changing career opportunities for graduates would seem to call for a re-evaluation of Ph.D programs. By and large these programs have prepared graduates for teaching and research careers in the experiment stations and associated colleges. However in the future only a small proportion of graduates will find openings in these institutions. One might question whether current Ph.D programs adequately prepare the majority of Ph.D graduates who will pursue nonteaching careers in business and government or as faculty members of nonagricultural colleges.

In agricultural economics, for example, one might question whether the trend towards more mathematics and abstract model building serves the best interest of the vast majority of agricultural economics graduates? This kind of training comes at a cost. Less time can be devoted to developing a facility for applying economic theory and empirical methods to real world problems and issues. Yet the vast majority of agricultural economists, and general economists for that matter, make their living doing this kind of work, either inside or outside of academia. Thus the trend in the training and the demands of the larger market appear to be diverging.

One might suggest a two path Ph.D program: one for aspiring faculty members who need to publish in the refereed journals to gain tenure and another for those expecting to pursue nonacademic careers. The problem is that it is not possible to predict where employment will be found. When the profession was expanding, Ph.D candidates could be reasonably sure of landing a job in their area of specialty. No more. Now people work where they can find jobs. Also it is not healthy to establish a program where one group of students is perceived to be less capable than another, or as "second class" citizens of the department. Separate but equal is an outmoded concept in education.

Preparation for a job market characterized by a large degree of uncertainty and the likelihood of career changes places a greater challenge on the design of Ph.D programs. Graduates should be prepared for a variety of options. A good grounding in neoclassical micro and macro theory and statistics, along with a variety of problem oriented courses in ares such as marketing and prices, production, consumption, trade, development and resources now appear necessary for a well rounded program in agricultural economics. Revised Ph.D programs may have to require more coursework to achieve greater breadth and flexibility of training without sacrificing depth or quality. Also the increase in proportion of students from developing countries suggests that the demand for training in economic development and related courses has increased relative to that of the traditional fields. How to match the interests and skills of these students with the traditional research assistantship funding arrangements remains an unsolved problem. More flexibility in funding methods seems to be needed.

Concluding Remarks

For the most part Ph.D programs prepare graduates for research and teaching positions in academia. However the predicted stability of TRE numbers in experiment stations implies that the majority of new Ph.Ds will have to find positions outside of these institutions. A re-evaluation of Ph.D programs probably should be done to determine if they are appropriate, first for the students in the programs (more foreign students) and second for the job opportunities that will exist in the 1990s and beyond. In agricultural economics, for example, does the increased emphasis on mathematical economics and abstract model building serve the best interest of the vast majority of graduates who will pursue careers as applied economists either inside or outside of academia, and/or in developing countries? More breadth and flexibility in degree programs now seem advisable in view of the greater diversity of career paths.

FOOTNOTES

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

[2]USDA personnel are included.

[3]It is recognized that entomology includes work involving both crops and livestock but a separation between the two was not possible from the data. Probably the largest proportion is on crops.

[4]For related studies on specific fields see Freeman, Hansen, et al., and Huffman and Orazem.

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