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Determining an Effective Teaching/Research Composition for Agricultural Economics Faculty Positions

Steven Blank
South Dakota State University

DETERMINING AN EFFECTIVE TEACHING/RESEARCH COMPOSITION FOR AGRICULTURAL ECONOMICS FACULTY POSITIONS*

by

Steven C. Blank**

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**Associate Professor of Agricultural Marketing, Economics Department, South Dakota State University.

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Making more efficient use of resources in agricultural economics departments is an important challenge of this period of budget stress (Stanton and Farrell). Beattie noted that during such periods "...something must be done to relieve the pressure lest our universities be forced to reduce the quantity and/or quality of their output" (p. 209).

In suggesting a direction for necessary action, Beattie used an analogy from the theory of the firm to argue for a strategy of "revenue maximization" on the part of agricultural economics departments. To achieve an efficient resource allocation "a university department, like a multi-product firm, must choose an output combination subject to a set of constraints" (Beattie, p. 210). The outputs of universities have often been identified as teaching, research and extension (Bishop; Thatch; Beattie). The scarcest of all constraining resources over which a department head has some influence is faculty time (Beattie). Therefore, to evaluate departmental output strategies it is necessary to consider faculty performance relative to the allocation of their time.

Goals and Background

As part of such an evaluation, the general objective of this paper is to determine what might be the most effective allocation of faculty time between teaching and research.[1] Secondary objectives are to consider (1) what factors influence teaching effectiveness and research output, and (2) what is the relationship (if any) between teaching and research performance.

Previous studies of these issues have produced varied results. Some analysis (Bishop) has supported what Thatch called "conventional wisdom", which is the view that the functions of teaching and research are mutually reinforcing and that individual professional growth is best accomplished through a balance of both activities. This view of university teaching and research being complementary has led to results which contradict the Law of Comparative Advantage (Thatch). Studies by Snodgrass and by Hardin both concluded that specialization (especially in teaching) is not the best strategy for faculty pursuing advancement. Nevertheless, the "conventional" view is not always supported. Hess was unable to determine whether research involvement resulted in a neglect of teaching or had vitalized teaching. In addition, several studies implied that specialization in research, at the expense of teaching, is the best strategy for gaining advances in rank and salary (Broder and Ziemer, 1982; Strauss and Tarr; Sjo; Tobey). When summarizing the literature, Thatch (p. 51) concluded that:

> "Although one would find difficulty in arguing that research does not provide fresh and relevant information that can flow into classrooms, the functions of teaching and research surely seem competitive in terms of the professor's scarce resource time."

Methodology

This study proposes to use Beattie's analogy of the theory of the firm to determine the "revenue-maximizing" combination of outputs for an agricultural economics department by applying principles of production economics. Since only one input (faculty time) is easily varied by a department head and just two products (teaching output and research output) are assumed to be possible, the product-product model (Doll and Orazem) is appropriate for finding the maximum revenue (output) for "average" faculty positions and/or academic departments.

Analysis will center on the objective function:

(1) Maximize: $FO = R + T$
Subject to:
(2) $R = f_1(a,e,r,T)$
(3) $T = f_2(a,e,t,R)$

where

a = academic rank
e = years of experience
FO = faculty output
r = research composition of position (%)
R = research output
t = teaching composition of position (%)
T = teaching effectiveness

The simple model states that faculty output is the sum of two equally important parts,[2] teaching and research output, and that each of those parts is a function of several variables. Both teaching and research output are expected to be positively related to academic rank, years of experience, and the proportion of time spent on that activity. Also, the two types of outputs are expected to have a negative relationship with one another if the activities are competitive as hypothesized by Thatch. Other variables, such as salary incentives, peer pressure, and educational background, which may influence faculty output are not included in this analysis because other studies have evaluated them (Broder and Ziemer 1982; Broder and Ziemer 1980; Tom and Cushman; Broder, Centner and Ziemer).

Ordinary least squares regressions of the two constraining equations in the model will allow hypotheses tests related to the two secondary objectives of the study. Production possibilities for the two outputs will be estimated so that the general objective can be pursued.

Data and Its Collection

The data for this study was collected through a survey mailed in early 1984 to the heads of all 86 departments listed by James. Data obtained from 46 departments are used in this analysis.

Department heads were asked to provide certain information about each member of their current faculty without identifying anyone by name. Complete responses were received for 401 faculty members. A summary of the results is presented in Table 1.

Some of the data in Table 1 is surprising. The two columns reporting publication output[3] imply that 1983 was a good year for research. For each rank the reported output of 1983 exceeded average annual output (although just slightly for assistant professors). However, it is likely that 1983 data is overstated due to reporting of publications which appeared (or will appear) in 12-month periods preceding (or following) the date of the survey. The column reporting average annual publication output (total output divided by years of experience) is likely to be more representative of faculty production and, therefore, will be used in this analysis as typical research output (R in the model). The inverse relationship between academic rank and average annual research output implies that as faculty are promoted their interests and/or responsibilities broaden in scope, resulting in declining publication rates.

The data for teaching effectiveness shows a trend similar to that described above for average annual publications. Although the rating for assistant professors was the highest, it is important to note that an analysis of variance found no significant difference between the ranks at the .05 level. Across the entire sample, scores ranged from 20 to 100.

To give some insight into how teaching effectiveness ratings were given, department heads were asked, "what factors do you consider when judging the effectiveness of teachers and their teaching performance?" Responses to the open-ended question are presented in Table 2. It is worth noting that all respondents listed more than one factor. From the diversity of factors listed in Table 2, it appears that a "standard" approach to evaluating teachers does not exist in agricultural economics departments.

TABLE 1. SUMMARY OF DATA ON AGRICULTURAL ECONOMICS FACULTY MEMBERS

Academic Rank	N	Average Years Experience	Publication Last Year (a)	Total Pub. Per Year Exper. (b)	Teaching Effectiveness (c)
					%
Professor	181	18.6	3.6	1.7	78.4
Associate	125	10.3	3.3	2.0	78.9
Assistant	82	4.5	2.4	2.3	80.5
Lecturer	13	---	---	---	---
Total/Mean	401	13.7	3.2	1.9	78.9

(a) Publications is a total score with books equalling 5 articles. Therefore, the average of 3.2 means that 3.2 articles was the average output of each person in the sample. No quality distinction was made. Standard deviation for sample: 3.8

(b) This figure divides each person's career publication total (books = 5, articles = 1) by their years of experience to represent average annual output. Standard deviation: 1.7

(c) This score is reported on a percentage basis with 100 being the highest level of effectiveness. Standard deviation: 13.1

TABLE 2. FACTORS USED BY DEPARTMENT HEADS WHEN JUDGING TEACHER EFFECTIVENESS

	Factor	Percent of Dept. Heads Specifying Factors (a)
1.	Student evaluations (formal)	64
2.	Course preparation & organization (syllabi)	50
3.	Comments from other faculty	48
4.	Comments from students (informal)	45
5.	Command of subject	29
6.	Review of teaching techniques, tools, & materials	24
7.	Course enrollments	19
8.	Student motivation, involvement in class	19
9.	Ability to relate econ to students	19
10.	Accessibility to students	17
11.	Interest and enthusiam for students & subject	17
12.	Student performance later (in other classes, on job)	14
13.	Communication skills	10
14.	Courses taught	10
15.	Visits to class	10
16.	Test results (student grades)	7
17.	Fairness in procedures (grading, etc.)	7
18.	Participation in committees related to teaching	5
19.	Other	7

(a) Column does not total 100 percent due to multiple answers given by respondents.

The "effectiveness score" can be used as a valid measure of teaching output(T) only if an unlikely assumption is made - that the score is a ratio level measurement (Stevens). It is reasonable to make such an assumption when comparing faculty members within one department. However, it is a ratio level measurement between departments only if it is assumed that department heads use identical measuring techniques. Table 2 shows this is not the case, so the results below have some degree of measurement error (Katzner; Blank). It is not the intention of this paper to argue that the effectiveness score used here is "best" - its shortcomings have been noted. Nevertheless, the score is used as a ratio level measurement to allow appropriate calculations and the discussion which follows. It is left for future research to provide the "best" quantitative measure of teacher effectiveness.

Empirical Results

Stepwise regressions (Nie et al.) for equations (2) and (3), respectively, led to the following results:

$$\text{(4)}\quad \underset{(9.27)}{R = 2.170} + \underset{(1.85)}{.438a_1}, + \underset{(3.51)}{1.133a_2} - \underset{(-6.00)}{.099e} + \underset{(2.69)}{.008r}$$

$$R^2 = .11 \qquad F = 7.97$$

$$\text{(5)}\quad \underset{(43.70)}{T = 79.015} + \underset{(1.17)}{2.246a_1}, + \underset{(2.59)}{6.777a_2} - \underset{(-4.03)}{.539e} + \underset{(3.36)}{.080t}$$

$$R^2 = .06 \qquad F = 6.84$$

In the equations a_1, is a dummy variable for the rank of associate professor, a_2 is a dummy for the rank of professor, and the numbers in parentheses are t-statistics. In both (4) and (5) the dummy variable for associate professor was left in the equation because it contributed to the explanatory power of the expression (its t-statistic was greater than one) even though it was not significant at the .05 level. Using the same standard, the independent variables R and T were each dropped from their respective equations.

The implications of the results above are that there is no significant relationship between teaching effectiveness and research output and that a great number of variables are likely to influence each of them. The low R^2 values for (4) and (5) indicate that more intensive modeling is needed to develop a good explanation of teaching and research performance, but the variety of possible independent variables, such as those in Table 2, may make such an effort unlikely to succeed; too many of the variables are qualitative in nature.

Teaching and research output may be indirectly related even though there is no significant relationship between them directly. It is noted that the composition of faculty time allocated to each activity was significant in both (4) and (5). Therefore, it is reasonable to compare production possibilities for the two outputs to determine an effective allocation of faculty time.

Production possibility curves can be derived directly from production functions, but this often leads to complex algebraic forms. In this case the R^2 values for both production functions estimated[4] were less than .10 making any derivations suspect. In such circumstances, Doll and Orazem suggest that evaluating production possibilities can be more easily approached by considering the direct allocation of inputs to enterprises (pp. 176-9). By comparing a production possibility curve with the appropriate isorevenue line the maximum revenue combination of outputs can be found at their point of intersection, where the marginal rate of product substitution of the two outputs equals the output price ratio. This is expressed

$$(6) \quad \frac{\Delta Y_2}{\Delta Y_1} = -\frac{P_{Y_1}}{P_{Y_2}}$$

with Y_i being the ith output and P being the unit price of the outputs. In a tabular approach this process is made simple.

By observation of Table 3 the maximum revenue combination of teaching and research outputs is that which corresponds with a 30-70% allocation of faculty time, respectively, between the two activities. The total revenues (performance) index of 230 is the highest of all time allocations considered.

To interpret the results presented in Table 3 it is necessary to first understand how output revenue (performance) is being measured. For a 30/70 teaching/research time allocation, for example, the typical faculty member's performance is about average (100.8) as a teacher and is 29.2 per cent above average as a researcher, compared to the sample of 401 people. These results depend on a set of assumptions, however, which affect how production outputs are measured. The production possibilities listed in Table 3 are derived by assuming a quality factor of one for research output (see footnote 2) and a quantity factor of one for teaching output. The assumption concerning teaching output implies an emphasis on the quality of "learning" passed on to students, regardless of how many students a teacher contacts. (Hence, a faculty member with zero classroom teaching responsibilities can have an "output" index of 90.7 for teaching simply because they contact some students outside of classroom settings.[5]) An alternative assumption is possible if the number of students contacted is of concern.

Table 4 presents the same information as Table 3 except that the revenues from teaching have been adjusted to reflect the quantity of students contacted. The teaching effectiveness scores in Table 3 have been multiplied by the fraction of time allocated to teaching to get the revenues reported in Table 4. Under this assumption, the more students contacted, the more "learning" passed on by a teacher and, hence, the higher the teaching output. As would be expected, the maximum revenue combination of outputs has shifted to an input allocation favoring more teaching time (80/20).

TABLE 3. COMPARING FACULTY PERFORMANCE (REVENUES) IN TEACHING AND RESEARCH WITH VARYING ALLOCATIONS OF TIME

Time Allocation T/R (%)	Observations N	Production Possibilities[a] T	R	Revenues[b] (Performance) T	R	Total Revenues (Performance)
0/100	14	71.6	1.20	90.7	64.6	155.3
10/90	31	78.9	.94	99.9	50.7	150.6
20/80	44	79.2	1.76	103.3	94.5	194.8
30/70	69	79.6	2.40	100.8	129.2	230.0
40/60	56	73.4	2.35	93.0	126.1	219.1
50/50	81	78.2	2.01	99.1	108.0	207.1
60/40	21	86.5	1.64	109.6	88.3	197.9
70/30	17	85.2	1.62	107.9	87.0	194.9
80/20	13	79.0	1.67	100.1	89.6	189.7
90/10	6	81.8	1.20	103.6	64.6	168.2
100/0	49	81.9	1.03	103.7	55.3	159.0
Total/Mean	401	78.9	1.86	100	100	200.0

[a]The numbers are the average teaching effectiveness score and average publications per year for faculty with the specified time allocation.

[b]These are index numbers (base=100) derived as follows: (production/mean production) x 100 = revenue. This implies that the "price" per unit of teaching effectiveness is 1.27 index points and the value (price) of one publication is 53.76 index points.

TABLE 4. COMPARING FACULTY PERFORMANCE (REVENUES) WITH EMPHASIS ON QUANTITY OF STUDENT CONTACT BY TEACHERS

Time Allocation T/R (%)	Revenues[a] (Performance) T	R	Total Revenues (Performance)
0/100	0.0	64.6	64.6
10/90	10.0	50.7	60.7
20/80	20.1	94.5	114.6
30/70	30.2	129.2	159.4
40/60	37.2	126.1	163.3
50/50	49.6	108.0	157.6
60/40	65.8	88.3	154.1
70/30	75.5	87.0	162.5
80/20	80.1	89.6	169.7
90/10	93.2	64.6	157.8
100/0	103.7	55.3	159.0

[a]The numbers for research are the same as in Table 3. The numbers for teaching are the revenues in Table 3 multiplied by the fraction of time allocated to teaching.

Summary and Conclusions

This study has presented the product-product model from production economics as a possible tool for use by agricultural economics departments when allocating the scarce resource of faculty time. Data from a survey of North American departments was used to estimate an effective teaching/research composition for faculty positions and/or departments. Overall, a 30/70% allocation of time, respectively, between teaching and research was found to be the most effective in maximizing faculty performance. However, when quantity of student contact is of major concern an 80/20% allocation favoring teaching was found to be most effective.

The results above have wide ranging implications for academic agricultural economists. Apparently the "conventional wisdom" that a mixture of both teaching and research activities (rather than specialization) is best for faculty is supported, in general, by the analysis. However, this does not mean that the two activities are universally complementary - in fact, they are more often competitive. Tracking[6] the revenue columns for teaching and research in Table 3 it is seen that the values change in opposite (competitive) directions over six of the ten arcs in the performance curves. In Table 4 the activities are competitive over seven of the ten arcs. Therefore, the irregular production possibilities curves for the teaching-research model have both competitive and complementary sections. It could also be argued that the complementary sections are nearly supplementary. In Table 3, especially, the small amount of change in teaching performance between time allocations (range of 18.9%) and the non-zero beginning score for allocations with no time assigned to an activity both suggest that teaching and research can be supplementary. This is possible if there are surpluses of resources occasionally. Apparently some academic institutions believe faculty have temporary surpluses of time because several survey respondents noted that publications were required of full-time (100%) teachers.

It was observed also that teaching effectiveness and research output are not related statistically. This contradicts the common hypothesis that the quality of a teacher's performance will decline if that teacher becomes involved in research work. However, the amount of time spent in an activity is one factor, among many, that is expected to influence faculty performance.

Footnotes

1. Extension activities are included in the "research" category for this analysis because both functions take place outside of a formal classroom setting and usually lead to written output (Bradford).

2. In some departments, such as non-Land Grant teaching institutions, the assumption of equal importance for teaching and research may not be appropriate. In such cases the objective function could be

$$FO = b_1R + b_2T$$

where $b_1 + b_2 = 1$ and $\frac{b_1}{b_2}$ measures the relative importance of R and T to the evaluating department.

3. So as to reduce the number of necessary assumptions, no quality distinction was made between the types of publications, as was done by Broder and Ziemer (1982). In this study, although quality differences do exist, it is assumed that all publications reported met a minimum quality standard required for release by the reporting institution.

4. Several models of the relationship between the input of faculty time and each of the outputs were tested with the best results being the following:

$$R = 1.071649 + .000881(r)^2 - .000009(r)^3$$

$$(6.07) \quad (5.70) \quad (-5.51)$$

$$R^2 = .08 \quad F = 16.31$$

$$T = 69.40 + 6.21(\log t)$$

$$(26.45) \quad (3.75)$$

$$R^2 = .03 \quad F = 14.03$$

5. It is likely that faculty with no teaching allocation at the time of the survey often had taught in the past and, therefore, were rated on past, rather than current, performance. This is another source of

measurement error which, it is expected, inflated the teaching scores of people with 0/100% T/R allocations.

6. Tracking involves first-differencing the revenues between successive time allocations and comparing the signs to see whether teaching and research revenues are changing in the same direction.

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