The Optimal Allocation of Faculty in a College Of Business

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Abstract

Aims: *This paper seeks to find the optimal allocation of tenure track faculty across the disciplines in a College of Business.*

Method: *This paper uses a Cobb Douglas Utility Function to derive the general solution to the allocation problem. The University of Central Arkansas is used as a case study. Data from this school is used to derive the parameters in the utility function. The optimal allocation of faculty members across disciplines is compared to the actual allocation.*

Results: *This paper finds the optimal number of faculty in a discipline will increase with: 1) the number of students taught in a discipline, 2) the salaries graduates receive with a major in the discipline, and 3) the college budget. The optimal number of faculty in a discipline will decrease with faculty salary in that discipline.*

Conclusions: *In this case study, the college should hire more economists and scale back their Marketing and Management Information Systems programs. The approach taken in this case study can be readily applied at any College of Business.*

Key Words: faculty allocation, utility maximization, case study, and cobb douglas

Introduction

There are some beliefs and practices that do not stand up to scrutiny. George Stigler contended that in the 1960's and 1970's economists and the general public thought that monopolies were everywhere. This was an unsupported notion. Stigler measured market concentrations in industries and found that monopolies did not exist, at least not without government protection.[1] Today's universities have widespread notions that are unsupported by evidence, but determine university policy nonetheless. For instance, college administrators often place an equal value on any type of undergraduate degree. They measure success in terms of the number of graduates in a year, or the number of students enrolled in classes. No one bothers to examine whether students in the different fields can find jobs, or what their salaries are. An Accounting major who finds a job earning $46,000 should not be counted the same as a Political Science major who takes a job at Wal-Mart stocking shelves for $16,000 a year. College administrators who do not take into account student outcomes are likely to devote too many resources to the fields of study that do not provide students with a path to jobs or high wages.

College administrators have a belief that the number of faculty allocated to a department in the past should be continued in the future. They are very reluctant to change the size of departments. It is often very easy for a department to get approval to replace a retiring faculty. This is true even in departments that have low student enrollment. In contrast, it is very difficult for a department to get a new faculty line. Administrators often approve replacement lines in overstaffed departments at the expense of approving new lines in departments that could teach many more students with the additional faculty. Johnson & Turner (2009) claim that internal politics, rather than rational economic decision making, explains variations in student-faculty ratios across disciplines.

This paper attempts to apply some scrutiny to the decision of how to allocate faculty lines across a College of Business. We use the University of Central Arkansas as a case study. We use standard optimizing techniques to determine how many faculty should be hired in each of the seven disciplines that offer majors within the college.

We compare the optimal results to the actual distribution of faculty members and suggest changes that should be made. We conclude by offering suggestions to the College. However, the results of this study are not only of interest to the University of Central Arkansas. This paper provides a roadmap for administrators who wish to allocate their university's resources more efficiently. The approach given here can easily be applied at any college.

Literature Review

It is well documented that the faculty to student ratio varies by department. Johnson & Turner (2009) attribute this variation to changing student demand over time. Using data collected from comprehensive public universities, they note that in 1966, 34% of all Bachelor of Arts degrees were in education, and only 13% were in business. Over time, the relative importance of these two majors changed. By 2005, only 11% of the students majored in education, while 27% majored in a business field. They also point out that faculty slots in departments did not change proportionally with changing student enrollment. They estimate that a 1% increase in student demand for courses in a discipline leads to an increase in that department's faculty by 0.044% in the short run, and 0.6% in the long run. The authors conjecture that politics rather than rational economic decision making is responsible for the slow and incomplete adjustments in faculty slots to changing student demand.

Becker, Greene, & Siegfried (2010) also find a slow adjustment process in faculty allocation across departments. They analyze the number of economics faculty in 42 departments over a 14 year period. When examining PhD granting schools, they find that undergraduate enrollment in economics classes has no influence on the number of faculty in the department. Instead, one additional faculty member is added when the long run average of PhDs awarded increases by one.[2] In contrast, the number of faculty slots in the department is influenced by undergraduate student enrollment in schools that do not offer graduate degrees. The perceived permanence of the increase in students affects the responsiveness of faculty slots to enrollment. The less permanent the change in enrollment, the less influence a change in enrollment will have on the number of faculty lines in a department. They find that a long term increase of 10 new majors a year will result in a new faculty slot. They find that if the three year moving average of majors increases by 27, a new faculty line is created. A one year increase in majors has no influence at all.[3]

Much like faculty slots, budget allocations also vary across departments. However, budget allocations do not seem to vary with enrollment like faculty lines do. Luna (2009) creates a model to explain budget allocations across the departments of a university. He finds that several measures of number of students taught were not important explanatory variables. The number of majors, degrees conferred, and student credit hours were insignificant at the 10% level in an equation explaining the department's budget.

Some research has considered the role of prices in creating an optimal allocation of faculty members across departments. Ehrenberg (1999) notes that the relative price of faculty members have increased for science and engineering faculty, mostly because their research equipment is getting more expensive. He advocates that schools substitute away from hiring faculty with high relative prices.[4] Feldstein (1993) in a comment on Rothschild & White (1993) calls for increasing the tuition for classes with a high marginal cost, while lowering the price of classes with a low marginal coat. Students will enroll in more of the low cost classes. Feldstein believes that changes in student enrollment will lead to new faculty being added in departments that add students and faculty lines will be dropped in the high marginal cost departments that lose students.

This paper will create a model to determine the optimal quality of faculty across departments. It will give deans and other administrators a roadmap of what changes they should make in the distribution of faculty lines. It will also identify the departments where administrators are likely to meet the most resistance to these changes.

The Model

We try to determine the optimal allocation of faculty members across the College of Business at the University of Central Arkansas. We treat this as a utility maximizing problem. We assume that the state run college is trying to promote society's welfare. In this vein, the college wants to educate students and it gains more utility as it educates more students, and as those students become more valuable members of society. In order to educate students, the college must hire professors. Professors impart utility upon the college that is determined by how many students they teach, and by how much their courses improved the knowledge and abilities of students.

We employ a Cobb Douglas utility function.[5] The Cobb Douglas specification yields a well behaved utility function. In two dimensional space, a utility curve will be downward sloping. Also, there will be a Diminishing Marginal Rate of Substitution. A Cobb Douglas utility function assumes that Marginal Rates of Substitution depend upon the ratio of the choice variables, and not upon the size of the budget. This assumption seems to fit the college's situation. To illustrate, if the College's budget were to increase by 25%, the optimal proportions of faculty members in each discipline would remain constant. This is consistent with the notion that UCA is a school of about 12,000 students. The increased budget would not require the college to direct its resources differently. It is not as if at low levels of a budget UCA has to make sure that it provides enough accountants for the state, and then at higher budget levels UCA can start concentrating on providing Finance majors. The extra students that additional faculty could teach will easily be absorbed by the labor market. UCA does not produce enough graduates to alter the values (or wage rates) of workers in any of their disciplines. Entry level positions are so numerous that any one school's graduates are price takers when it comes to their wages.

More formally, the college will maximize its utility subject to a budget constraint. The model appears below in the familiar Lagrangian form.

$L = \max U(X_1^{a1} X_2^{a2} X_3^{a3} X_4^{a4} X_5^{a5} X_6^{a6} X_7^{a7}) + \lambda\,(I - P_1X_1 - P_2X_2 - P_3X_3 - P_4X_4 - P_5X_5 - P_6X_6 - P_7X_7)$

Each X represents the number of faculty in a teaching area. There are seven teaching areas. I is the money to be allocated to faculty salaries. P_i (where i=1…7) represents the wage earned by a faculty member in teaching area i. The parameters a_i (where i= 1 …7) represent the relative importance of the faculty members in each field of study to the College of Business. As with any Cobb Douglas utility function, the sum of the parameters, a_i, equal one.

A monotonic transformation of this function will not alter the optimum choices. Taking the natural logarithms of this function yields:

$L = a_1 \ln X_1 + a_2 \ln X_2 + a_3 \ln X_3 + a_4 \ln X_4 + a_5 \ln X_5 + a_6 \ln X_6 + a_7 \ln X_7 + \lambda(I - P_1X_1 - P_2X_2 - P_3X_3 - P_4X_4 - P_5X_5 - P_6X_6 - P_7X_7)$
The first order conditions are:
$dL/dX_1 = a_1/X_1 - P_1\lambda = 0$
$dL/dX_2 = a_2/X_2 - P_2\lambda = 0$
and so on for all seven cases. More generally,
$dL/dX_i = a_i/X_i - P_i\lambda = 0$ where (i=1 … 7)

These first order conditions can be rearranged to solve for a_i.
$a_1 = P_1\lambda X_1$
$a_2 = P_2\lambda X_2$
or more generally, $a_i = P_i\lambda X_i$

Next, sum the left side and right-side of the seven equations of a_i.
$a_1+a_2+a_3+a_4+a_5+a_6+a_7 = \lambda(P_1X_1+P_2X_2+P_3X_3+P_4X_4+P_5X_5+P_6X_6+P_7X_7)$

The left side of this equality equals one because the parameters of a Cobb Douglas Utility function sum to one. The sum of the quantities inside the parenthesis on the right side of the equality must equal I, the budget for faculty. The typical constrained maximization problem assumes that the entire budget is spent. In this problem, the seven choice variables multiplied by the price of each variable will use up exactly all of the income to be spent on faculty. The equation above reduces down to:
$1 = \lambda * I$
Therefore, $\lambda = 1/I$
Remember that since $a_i = P_i\lambda X_1$
We can solve for X_i
$X_i = a_i/\lambda P_1$
We can plug 1/I in for λ to get
$X_i = a_i I/P_i$

This is the solution to the maximizing problem. The number of faculty members in each discipline is determined by the relative weight faculty members in this discipline give to the college's utility function (a_is). The money that will be spent in faculty salaries (I), as well as the wage (P_i) of the faculty members in this discipline.

Parameter Values at UCA.

There are seven majors in the College of Business at UCA. They are: Accounting, Management Information Systems, Marketing, Management, Economics, Finance, and Insurance. The utility function above will be used to determine how many faculty members the college should have in each of these seven areas. X_1 is the number of faculty in Accounting, X_2 is the number of faculty in MIS, and so on. This section presents values for a_i, and P_i, which can be used to find the optimal values for each X_i.

The parameters (a_i) measure how important the faculty in each subject area are in determining the college's utility. We determine the value of each a_i by calculating the value the students in each discipline add to society's welfare. The information used for these calculations appears in Table 1. Column 2 lists the number of students taught by professors in each field of study during the Fall and Spring semesters of the 2009 – 2010 school year. There were 8,618 students in classes taught by professors in these seven subject areas. Management taught the most students (1,992), while Insurance taught the fewest (266). On average each field of study had 1,231 students taking their classes.

In order to meaningfully use wage data for each discipline to construct our parameters (a_is), we convert The Number of Students Taught to the number of students taught in a discipline if every student majoring in that discipline had to only take classes in that teaching area. UCA requires a student to take 124 credit hours to graduate. A typical class is three credit hours. Therefore, we divide 124 by 3 to get 41 1/3. This is the number of courses a student has to take to graduate. Next, we divide the Number of Students Taught (column 2) by 41 1/3. The results appear in column 3 under the title Full Time Equivalent. If the 987 students who took MIS classes only took MIS classes in an academic year, the MIS faculty could teach enough classes so that 23.88 students could graduate. All seven fields considered together offered enough classes to satisfy the requirements of 208.5 students. Insurance professors only offered enough classes to graduate 6.43 students. Management offered enough classes to graduate 48.19 students. The average field of study offered enough classes to graduate 29.79 students.

Next, we need to put a value on the student's education. We use the disciplines starting wage rate as a measure of value for the education that the students received. The salary information was obtained from a Wall Street Journal Survey.[6] The salaries range from $40,800 for a marketing major to $50,100 for an Economics major. The mean salary across these five majors is $46,414.29. We were not able to find a separate salary figure for an insurance major, so we used the salary for Finance majors as a proxy. Finance is the closest field to Insurance, so it is likely to provide the best representative salary.

In a competitive market, the Value of the Marginal Product of Labor is equal to the wage rate. Therefore, the salary is a good indication of the value that a student is adding to society. He or she will be paid the value of his or her output. However, the college cannot take credit for building all of the skills that make a college graduate productive. An accounting major can expect to earn $46,000 in her first year. However, the median salary for a high school graduate is $30,436.[7] The difference between a major's starting salary and a high school graduate's starting salary reflects the value the college degree added to the individual's earning ability in her or her first year of work. The degree added $15,564 to the accountant's salary. If students are paid the marginal value of their output, this difference captures the difference in the value of a worker's output when a degree is obtained. A degree in Marketing only added $10,364 to a student's salary and thus to the value of her work, while an Economics degree added $19,664 to a student's salary and to the value of her work. The differences in salaries between a major and high school student are listed in column 5.

To calculate the total value of the student's education in each field of study, we multiplying the number of Full Time Equivalent students (column 3) taught by professors in each field by the salary difference between the major and a high school student (column 5). The result is the value to society from the course work taught by professors in each field. These results appear in column 6. The total value of the college graduates taught in the 2009-2010 academic year was $3,255,956.90. Economics, Management, and Accounting provided the most value. These fields provide over $600,000 dollars of value per year that the students will work. Insurance provided the least value at $112,389.29.

The relative importance of each discipline in determining UCA's utility appears in the final column label Fraction. These are the values of all the a_is in the utility function. The fraction is calculated by taking the Total Value for a discipline (column 6) and dividing by $3,255,956.90.

The divisor is simply the total value to society of all the education UCA provided in these seven areas of study during the 2009-2010 academic year. Economics provided 27% of the value of the education produced, followed by Management, which provided 18.6% of the total value of the education provided. Insurance, mostly because of the few number of students taught, only provided 3% of the value of the education provided. The sum of all the fractions will equal one.

We will solve for the optimal number of faculty in each discipline using several different faculty wage rates, which are presented in Table 2. The second column lists the AACSB averages for a new hire at the assistant level. This would be the wages a college would have to pay if it were starting from scratch. The most expensive faculty are in Finance, Insurance and Accounting, while the least expensive faculty are in Economics and MIS. Of course, colleges cannot hire all new professors each year. They grant tenure and have long term relationships with many of their faculty. We use two different approaches to find a representative wage that take into account that schools will not hire all new assistant professors to staff their classes. The third column presents the average wage for an Associate Professor in an AACSB Business School for each discipline. The biggest difference between the new hire wages and the associate professor wages is in MIS. The new hires are only paid $87,000, while the Associates are paid $108,300. This may be caused by a drop off in hiring in MIS. In 2009, 5.6 of the position filled at business schools were in MIS. This is down from 17.6% in 2000 and 11.1% in 1996.[8] The next largest difference is that new hires are paid $127,800 in Accounting which is $12,200 more than Associate level accountants make. The final column is the average wage paid by UCA in each discipline. These salaries are lower than the discipline averages with one exception. MIS faculty at UCA make more on average than new MIS hires. The other biggest difference is that in both national level averages, Finance was the highest paid discipline. At UCA the Finance average was only the third highest salary average.

The final parameter needed to obtain the optimal allocation of faculty positions is income. Income will be discussed in the following section.

Solving for the optimal allocation of faculty.

First, we consider the optimal number of tenure track (or tenured) slots. UCA spends $2,963,185 in salaries on tenured or tenure track faculty in the seven fields of study.[9] However, not all of this money is allocated toward undergraduate education. UCA offers an MBA and a Masters in Accounting. The number of graduate school classes taught by each discipline in the 2009-2010 academic year is listed in column 4 of table 3. We find the faculty member teaching each graduate class and calculate 1/6 of his or her salary. A typical tenure track faculty teaches 6 classes during the Fall and Spring semesters, so one sixth of a salary represents the portion of the annual salary devoted to graduate instruction. The total salary spent on graduate school instruction was $239,256.80. This is subtracted from the total amount spent on tenured and tenure track salaries. The result, $2,723,928, is the amount UCA devotes toward undergraduate education staffed by tenured or tenure track faculty.

We calculate the optimal allocation of tenure track slots using the equation:

$X_i=a_iI/P_i$

I is $2,723,928. The values for a_i are found in the last column of Table 1. We will use several different values of P_i. In our first specification, we use the wages of a new hire for P_i, which are found in Table 2. The results appear in the second column of Table 3.

The second column gives the optimal number of tenure track slots for each field of study. Column 3 gives the actual slots. UCA has 32 tenured or tenure track faculty in these disciplines.[10] Column 4 has the number of graduate classes taught by each department. This number is divided by six to obtain the number of full time faculty devoted to graduate education. For instance, MIS teaches 3 graduate classes. Three divided by six yields ½, which is the amount of MIS full time faculty devoted to graduate education. The number of full time graduate faculty is subtracted from the actual number of tenured/ tenure track slots in the discipline. The result is reported in column 5 under the label the Actual Tenure Track Slots devoted to undergraduates. The total number of tenure track slots devoted to undergraduate education is 29.5. This is more than the optimal number of slots (26.31) because UCA pays its faculty less than the salaries that new hires would earn.

The final column subtracts column 5 from column 2. This gives the difference between the actual number of positions and the optimal number of positions. A negative number indicates that the discipline is over staffed, and a positive number indicates how many positions the discipline should add.

Management seems to be staffed at close to the optimal levels. The optimal number of faculty is 0.126 members more than the department has on staff. Economics is the only field that is significantly understaffed at this budget and faculty salary schedule. The results suggest that 4.51 new positions should be added. That is, the economics department should more than double. It should not be surprising that the optimal number of economics faculty was quite high. The relative value of economics faculty to the college's utility (a_i) is 0.272. This is the second highest weight in the college. Management and Accounting weights of 0.186 and 0.185, and all the remaining disciplines had lower weights. The high weight in the economics department resulted from two sources. First, they taught more students than any discipline other than management. Economics taught 1,859 students, management taught 1,992, and the remaining disciplines all taught fewer students. Second, the salary survey discussed in Table 1 found that Economics majors had the highest starting salary. Therefore, an economics student added more utility to the college's utility function than any other student from another discipline. Finally, economists are cheap faculty to hire. A new hire in Economics should cost only $88,700. Except for MIS, all other new hires will cost $105,700 or more. In sum, economics faculty educate a lot of students, the value of the education is quite high and these faculty can be purchased at a low price, which all lead to a high optimal number of economics positions.

Several disciplines are over staffed. The most extreme case is marketing. Our results suggest that Marketing should have 2.34 fewer tenure track slots. Again this result falls out of the parameters used in the optimizing equation. Marketing's weight in the utility function is only 0.09. This low weight does not derive from the number of students taught by the marketing faculty. They taught 1,196 students, which is the fourth most of the disciplines considered. Instead, the low value of a_i is a result of the wage Marketing graduates earn. The starting salary for a marketing major is only $40,800. This is $2,200 less than the next lowest salary. The low salary indicates that the value added in these classes is less than the value added in the classes taught in the other six fields of study. The price of a faculty member also drives this result. Marketing faculty are expensive at $107,800 for a new hire. In sum, Marketing faculty offer a product that provides less value added to students than other disciplines in the College of Business, while at the same time these faculty are expensive. Therefore, it should be no surprise that the optimal number of Marketing faculty is not very high.

Finance is over staffed by almost a complete position. The low number of optimal faculty is a result of the high salaries new hires in Finance would earn. MIS is also overstaffed by one person. The small number of students in MIS classes is driving this result. MIS teaches only 272 more students than Finance but has twice as many faculty.

Accounting appears to be over staffed by two positions. However, caution needs to be taken in interpreting this result. The Accounting department is the only department that devotes a significant amount of resources to the masters program. Success of their masters program may require that they have more staff than a model based on undergraduate teaching would suggest. Also, in order to be able to take the CPA exam, students must take certain course requirements. In order to meet these course requirements, the college may need to hire more faculty than this model would consider optimal. Insurance also seems to be over staffed by 1.3 faculty members. The low optimal number of insurance faculty derives from two sources.

Insurance faculty are expensive and this discipline only teaches 266 students in a year. However, AACSB requires a discipline to have at least two faculty members. This way if one faculty member leaves, the whole program is not at risk. UCA's decision is really whether to have two Insurance faculty or whether to disband the program. Simply rounding the optimal number of faculty in insurance, which is 0.70 to the nearest number zero or two, suggests the program should be disbanded.

Next, we consider how using the other salary figures in Table 2 changes the results. First, we calculate the optimal allocation of faculty using the AACSB average salaries for Associate Professors. The results appear on the left side of Table 4. The optimal number of faculty members dropped by 0.61 when we use Associate Professor salaries were used instead of new hire salaries because of the greater Associate level salaries in some fields. The results here are very similar to those found in Table 3 when new hire salaries were used in the calculations. The results suggest UCA should hire 4 additional economists and let go 2 marketing faculty. The only really big difference between these two sets of results in the optimal level of MIS faculty. When Associate level salaries are used, MIS appears to be overstaffed by two positions. With the new hire salaries, MIS was only overstaffed by one position.

The difference in results can be explained by the large difference between these salaries. A new hire in MIS makes only $87,000, while an Associate Professor makes $108,300. When MIS faculty become more expensive, the optimal number of lines in that department will shrink. A smaller change occurred in Accounting. This department is overstaffed by 1.63 faculty members. The increase in the optimal number of accountants (from 3.95 to 4.37) occurred because associate professors in Accounting are less expensive than new hires.

Notice that the optimal number of tenure track faculty members that UCA should hire was less than the number of faculty that they had. UCA was able to do this because they usually pay their existing faculty less than the market rate. Next, we examine the optimal number of faculty that each discipline should hire when the pay is the salary is the average salary at UCA in that discipline. This assumes that they can hire as many faculty as they wish at the average salary that they pay in their discipline. The results appear on the right side of Table 4. Interestingly, given their wage structure, if UCA adopted the optimal allocation of faculty by discipline, they could hire almost one more tenure track faculty at their current budget. The optimal number of hires increases from the actual 29.5 faculty devoted to undergraduates to the 30.36 that would represent the optimal allocation.

Many of the results are consistent with the previous calculations. Marketing should lose about two positions, which was a consistent result throughout the various specifications. Insurance is overstaffed by more than one faculty member. Economics is extremely understaffed. Using UCA wages, the suggested increase in economics faculty slots is now almost 5 positions. This is about a half a position more than was suggested in the previous calculations. With UCA salary data, the MIS results fall between the estimates using the other salary data. In this case, the MIS department is overstaffed by about 1.4 faculty members. Finance appears to be appropriately staffed when UCA salaries are used.

There were two big changes in these estimates compared to the two previous sets of results. First, when we use UCA salary data, it appears that the management department should be expanded by 1.5 faculty positions. Previous estimates suggested that Management was staffed appropriately. The wide gap between UCA salaries in management and the AACSB averages drives this result. The average management professor makes $81,019.20 at UCA, which is over $20,000 less than the two AACSB averages presented in Table 2. The other big change is in the Accounting department. When UCA salaries were used, it appeared that the Accounting department was only overstaffed by one faculty member. Overstaffing was greater when AACSB wages were used. The low wages at UCA made this possible. UCA accountants are more than $15,000 below Associate level salaries and more than $28,000 less than new hire salaries.

Two recommendations that emerge from this analysis are quite clear and require significant changes to the present allocation. UCA should hire at least 4 new economists. They should also let go 2 marketing professors. This analysis also suggests some smaller changes. Insurance and MIS should both be reduced by one faculty member.

Robustness of Results.

In the previous analysis, three different salaries were used to calculate the optimal quantities of faculty members in each discipline. This section checks the robustness of these results by making some alterations to the model. First, we will examine whether the high salary that Economics majors earn are driving the results. The relative importance of economics faculty in the college's utility function (a_i) was 0.272. We redo the relative weights in our utility function, so that the weights are derived from lower salaries. First, we calculate the weights when economic graduates make the same amount as a Finance major. Finance graduate salaries are the median salaries among graduates in the survey. The starting salary is $47,900. The new relative weight for economics faculty drops from 0.272 to 0.249. We will use UCA salaries as the price variable in the preceding discussion. The new optimal number of economics faculty drops from 8.78 faculty to 8.04 faculty. This new number is still 4.21more faculty than the department has.

Next, we calculate a new set of weights for the utility function when an economic graduate only makes the same amount as a marketing major. A marketing major makes $40,800, and this is the lowest starting salary among the disciplines that we consider. Using the marketing salary, instead of the economics salary, changes the weight from 0.272 to 0.164 percent. This results in an optimal number of economics faculty of 5.31, which is still 1.48 faculty members more than the department has.

In all the large increases in the economics faculty that the model suggests are appropriate are partly driven by the high salaries that economists earn.

However, moving the economics salary down from the highest salary to the median salary still left us with a result that called for hiring 4 new economics faculty. Even using the lowest salary, which was from marketing, suggested that the economics department should hire more faculty. The low salaries of faculty members and the large number of students taught by economics faculty contribute to the need for more economics faculty even when the high value that economic education confers on students (as evidenced by the high wages) is removed from consideration.

Next, we examine whether the results are being driven by a few classes in some subjects that are taught largely by instructors instead of tenure track faculty. If these classes have large sections, then the number of students in a discipline may be inflated. UCA has two classes that are primarily taught by instructors. They are Global Environment of Business and Business Communication. These classes are taught in the Economics and Management departments. We exclude these courses from our tabulations of how many students are taught by the disciplines. The number of economics students drops from 1,859 to 1,266. The number of Management students drops from 1992 to 1,575. Table 5 presents the optimal number of faculty that UCA should hire when the weighting schemes remove the students taught in Business Communication and in Global Environment of Business sections.

The new weights are reported in column 2, and the optimal number of faculty appears in column 3. The difference between the optimal number of faculty in a discipline and the faculty devoted to undergraduate education appears in the final column. This modification did not change the major results very much. The economics department should still hire about three people instead of four, and marketing should still drop down by a position and a half. Management appears to need one more position, which is half a position fewer than the results obtained when the business communication classes were included in the parameter weights (a_is). The findings in this paper should be treated as a starting point in an iterative process. The college should clearly hire more economists and reduce its marketing department. However, these hires will have an impact on the relative weights of the college's utility function. With more faculty, the economics department will educate more students. With more students the weight of the economics faculty in the college's utility function will increase. With a greater weight, the new optimization solution may suggest that even more economists should be hired. It would all depend upon the unmet demand for economics classes by students. This will be revealed as administrators direct resources in their optimal way each year.

Optimal number of upper division level sections.

Many of the classes that students take in order to obtain a business degree are required regardless of the particular major a student chooses. They need to take certain number of classes from each discipline except insurance. This section looks the number of sections offered by a discipline that count toward a major but that are not required classes for all business majors. These are the classes that students have some choice about whether or not they want to take them. Some of these classes are electives within a major and some are required for a major. The number of students in these classes is an expression of the demand for the disciplines offerings.

Table 6 lists the number of upper division classes in the 2009-2010 academic year offered in every discipline. These courses are limited to classes that are not required classes for all business majors. Accounting offers the most classes at 27 while Economics offered the fewest at 5. The average class sizes appear in column 3. Marketing, Economics, and Finance all have class sizes that average over 35 students per class. MIS has an average class size (15.53), which is almost 10 students below the next smallest class size. Column 4 reports the full time equivalent students in each discipline's upper division level classes. As done previously in this paper, the figure is derived by taking the number of students in the classes and dividing 41.33. The weights used in the utility function are calculated just like they were in Table 1 Income was determined by dividing the number of sections taught by six to get the number of full time faculty needed to teach those classes. This number is multiplied by the average salary for that discipline. Then the money spent in each discipline on upper division level classes is summed. The price variable is simply the average UCA salary by discipline. Column 5 reports the optimal number of faculty needed in a discipline. Since each faculty typically teaches six sections in the regular academic year, column 5 is multiplied by six. This gives us the optimal number of sections in each discipline. Column seven reports the difference between this optimal number of sections and the actual number of sections offered. MIS clearly is offering too many sections. My results suggest that they offer 5.26 too many upper division sections. This result surely is caused by the low number of students in their classes.

At 15 .53 students per class, MIS is educating the fewest students per class. Accounting appears to offer three sections too many. Economics and Finance should both offer 4 more upper division sections per year. In percentage terms these are huge increases. This represents almost a 100% increase in economics offerings and almost a 50% increase in Finance offerings.

Conclusion

This paper used a constrained Cobb Douglas utility maximizing function to solve for the optimal number of faculty in each discipline in the College of Business at the University of Central Arkansas. The faculty members were the choice variable. We assumed that the College gained utility by educating more students and by the value society placed on this education. The value of each discipline's students was determined by the median wage new hires with that major earned. The solution suggests that the college should hire more faculty as the discipline educates more students and as it produces students who can earn higher wages. It also suggests that as a discipline's faculty salaries increases the college should hire fewer faculty from this discipline. We found that UCA was in need of major changes in the allocation of its faculty among departments. Most notably, the college needs to hire many more economists and reduce the size of its marketing department. The over staffing in Marketing appears to be at the staffing level of the marketing classes that are required of all majors in the college of business rather than in the level of staffing of its upper division level classes.

The next step for UCA is to collect its own data concerning the wages that its students earned. With such data this model can be solved using UCA data rather than salary data obtained from national surveys. Also, the budget for tenure track salaries was taken as a given in this paper. Further research could determine the optimal allocation of money across the colleges in a university. While this paper is a case study of one school, its importance is not limited to the situation at UCA. This paper provides a road map for administrators which will allow them to allocate their budget in a more efficient manner.[11]

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Table 1: Students in the 2009-2010 academic year

1) Field	2) # students	3) Full time Equivalent	4) Starting Salary	5) Difference from H.S.	6) Total Value	7) Fraction
Accounting	1,603	38.78	$46,000	$15,564	$603,607.06	0.185
MIS	987	23.88	$49,200	$18,764	$448,066.16	0.138
Marketing	1,196	28.94	$40,800	$10,364	$299,887.35	0.092
Management	1,992	48.19	$43,000	$12,564	$605,503.74	0.186
Economics	1,859	44.98	$50,100	$19,664	$884,404.26	0.272
Insurance	266	6.43	$47,900	$17,464	$112,389.29	0.035
Finance	715	17.30	$47,900	$17,464	$302,099.03	0.093
Sum	8,618	208.5			$3,255,956.90	
Average	1,231.14	29.79	$46,414.29			

Table 2: Salaries in College of Business Disciplines

1) Field	2) New Hire at Asst level	3) Discipline Average at Associate Level	4) UCA Average for Discipline
Accounting	$127,800	$115,600	$99,281.14
MIS	$87,000	$108,300	$91,469.50
Marketing	$107,800	$109,700	$92,674.8
Management	$105,700	$107,800	$81,019.20
Economics	$88,700	$90,700	$84,308.25
Insurance	$133,600	$127,000	$111,116.50
Finance	$133,600	$127,000	$97,154.67

Table 3: Optimal Number of tenure track slots when new hire salaries are paid

1) Field	2) Optimal Tenure Track Slots	3) Actual Tenure Track Slots	4) Grad Classes	5) Actual TT Slots Devoted to undergrads	6) Difference
Accounting	3.95	7	6	6	-2.05
MIS	4.31	6	3	5.5	-1.19
Marketing	2.33	5	2	4.66	-2.34
Management	4.79	5	2	4.66	0.126
Economics	8.34	4	1	3.83	4.51
Insurance	0.70	2	0	2	-1.30
Finance	1.89	3	1	2.83	-0.94
Total	26.31	32		29.5	

Table 4: Optimal Number of tenure track slots when Associate Professor salaries are paid

Solved using Associate Professor Salaries				Solved Using UCA Salaries	
Field	Optimal # Tenure track	Actual TT Slots Devoted to undergrads	Difference	Optimal # Tenure Track	Difference
Accounting	4.37	6	-1.63	5.09	-0.91
MIS	3.46	5.5	-2.04	4.10	-1.40
Marketing	2.29	4.67	-2.38	2.71	-1.96
Management	4.70	4.67	0.03	6.25	1.59
Economics	8.16	3.83	4.32	8.78	4.94
Insurance	0.74	2	-1.26	0.85	-1.16
Finance	1.99	2.83	-0.84	2.60	-0.23
Total	25.7	29.5		30.36	

Table 5: Optimal Number of Tenure track slots when Global Economics and Business Communication are excluded (UCA Salaries are used for price variable)

1) Field	2) Relative weight	3) Optimal #	4) Difference
Accounting	0.212	5.82	-0.183
MIS	0.157	4.69	-0.81
Marketing	0.105	3.10	-1.57
Management	0.168	5.65	0.99
Economics	0.212	6.83	3.00
Insurance	0.039	0.97	-1.03
Finance	0.106	2.97	0.14
Total		30.03	

Table 6: Salaries for Tenure Track, Allocation of Salaries in College of Business Disciplines

1) Field	2) # sections upper div	3) ave class size	4) full time equiv	5) optimal # faculty	6) optimal # sections	7) Difference (6-2)
Accounting	27	24.89	16.26	3.98	23.90	-3.10
MIS	19	15.53	7.13	2.29	13.74	-5.26
Marketing	19	37.26	17.13	2.99	17.96	-1.04
Management	21	31.04	15.77	3.82	22.93	1.93
Economics	5	36.6	4.43	1.62	9.69	4.69
Insurance	9	26.11	5.69	1.40	8.39	-0.61
Finance	9	35.78	7.79	2.19	13.13	4.13

Endnotes

[1] Stigler (1988) p. 91-112.

[2] Ehrlich (2006) notes that since 1997 the number of economics faculty at SUNY Buffalo has grown by 80%. During this time undergraduate enrollment was relatively stable. He attributes the growth in faculty to the four fold increase in graduate enrollment.

[3] The prohibition of mandatory retirement ages in colleges and universities, which became effective in 1994, may make it harder for college and universities to accommodate changes in student enrollment in a department with more or fewer faculty lines. See Clark & Ghent (2008); Clotfelter (1999).

[4] See also Ehrenberg, Rizzo, & Jakubson (2003).

[5] For an example of a regression estimate of a Cobb Douglas model explaining student enrollment in liberal arts colleges see O'Connell and Perkins (2003).

[6] http://online.wsj.com/public/resources/documents/info_degrees_that_pay_you_back-sort.html

[7] The median salary for a high school graduate was found at http://www.payscale.com. Payscale also provided the survey information published by the Wall Street Journal for the salaries by major.

[8] AACSB Salary survey, page vii.

[9] This excludes the salaries of department chairs, the dean, the associate dean, and the MBA director.

[10] We are not counting department chairs, the dean, associate dean, or MBA director since these positions were omitted in the salary data.

[11] Let me end with a disclaimer. This paper does not make any attempt to determine the capability of UCA's administration. To determine the administration's efficiency, I would have to determine the optimal allocation of faculty at several schools and compare each school's optimal allocation with their actual allocation. If UCA had a faculty allocation that was 25% different than optimal, and other schools were 5% different than optimal, then UCA would be inefficient. However, if UCA had a distribution of faculty lines that was 10% different than optimal and other schools had a 25% difference, then I would consider UCA to be efficient. I made no comparison of UCA to any other school. I do not even consider it an interesting research question to determine if UCA is efficient. The results are not generalizable and thus of very little value. Interesting research questions regarding efficiency might include: Are private schools closer than public schools to optimal allocations of faculty lines? Does the size of a university influence how close the school is to optimal allocation of faculty? Does a particular governance structure influence how close a school is to the best allocation of faculty lines?
What my paper does is provide a road map to an administrator who wants to allocate faculty lines in a manner consistent with economic optimization principles. I use UCA data as a way to provide an example. An administrator from say the University of Tulsa can use my model and apply it to data from his/her school to inform their personal decisions. The UCA data is presented to show how the calculations would be done. It is always easier to understand a concept when you have an example to work with. Of course, the model will yield different recommendations then the ones in my paper when applied to data from Tulsa (or elsewhere). The model will also yield different results at UCA when UCA salary data is employed rather than the national survey data.