TEACHING QUALITY, RESEARCH AND TENURE

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ABSTRACT

Our focus is on the interactive effect of scholarship and pedagogical training on teaching quality and the strategic behavior relating to the tenure decision. First we develop an optimal control model in which the department maximizes the discounted benefits to the students net of the cost of improving instruction. The quality of instruction, or benefits to students, is assumed to be a function of the instructor's human capital, which is, in turn, a function of scholarship or research and pedagogical training.

Next we develop a signaling model in which the faculty member may choose a level of human capital investment in order to influence the tenure decision. From the signaling game, we show the conditions for the existence of both pooling and separating equilibria.

INTRODUCTION

Untenured professors have a particularly strong incentive to demonstrate teaching proficiencies and published research. At many universities, such as the majority of state regional schools, the academic tenure decision is based on scholarship and teaching. Untenured professors must balance the significant pressure to have their research published with the expectation to be involved in teaching workshops and other forms of teaching training. Obviously, those who read and write for journals such as this recognize the important links between teaching and research. Unfortunately, on many campuses this interaction is not recognized. In practice, the interaction of teaching and research is mainly ignored and, at the worst, they are treated as incompatible activities. Much of the literature regarding the improvement of teaching economics has focused in specific techniques or integrated approaches which do not address the role of scholarship. Examples of recent recommendations have included the use of one-minute papers (see Chizmar & Ostrosky, 1998), the integration of technology into classroom teaching and the development of web-based courses (see Simkins, 1999; Vachris, 1999; Chizmar & Walbert, 1999; Stone, 1999).

However, recently the interaction of teaching and scholarship has been investigated in the context of the total quality management framework (see, for example, Chizmar, 1994; Ray, 1996). Paul and Rubin (1984) identify two components of good teaching. The first is classroom presentation, "the ability to communicate with and to motivate students" (p. 143). The second is the content of the course. Here the instructor's responsibility is to ensure that the material is both current and relevant. Actively engaging in research aids the faculty member in making these judgements by exposing him to current ideas and giving him the tools to weed out the weak or irrelevant ones. Extending the argument, one can conclude that improving presentation, while certainly useful, is not enough to guarantee improvement in the quality of student learning. Although Ray (1996), like many other works relating to TQM and teaching, does not explicitly discuss the role of research, if one looks more carefully at the place of the instructor in her model, the importance of research is apparent. The most obvious need for a researching faculty that Ray refers to is in the job of defining the product. This is analogous to what Paul and Rubin (1984) would refer to as controlling the content of the course. A faculty member who is not current cannot adequately ensure that his students are learning accurate, relevant material. Chen and Ferris (1999) argue that research is a desirable activity for professors at teaching universities since research enhances human capital that is necessary to improve the quality of faculty teaching. Research also aids in the instructor's role as a monitor of the quality of certain types of assignments, such as essays, research projects or take-home exams. Since research has intrinsic and spillover benefits unrelated to teaching, it follows that improving teaching is not the only motive faculty members engage in research.

Our focus is to formally investigate the interactive effects of scholarship and pedagogical training on teaching quality. First we will consider research as a means of improving classroom performance, since the goal of the department is to maximize the discounted benefits to the students net of the cost of improving instruction. The quality of instruction or benefits to students is assumed to be a function of the instructor's human capital, which is, in turn, a function of scholarship or research and pedagogical training. Given this framework, we then derive the optimality conditions for the continuous problem of human capital investment.

In the next model, we consider the strategic behavior that arises in the faculty member's self selection of the relative importance of scholarship and pedagogical training. Within this section, we develop a signaling model in which the faculty member may choose a level of human capital investment in order to influence the tenure decision. For simplicity, we assume that, depending upon his or her abilities and/or taste for work, the faculty member can be either a "high productivity" type or a "low productivity" type, and each type has similar teaching evaluations. The tenure decision is based on a composite score which depends on the instructors' level of research and investment in pedagogical training. From this analysis, we show the conditions for the existence of both pooling and separating equilibria. In the final section, we provide some policy implications and conclusions.

MAINTAINING HUMAN CAPITAL FOR TEACHING

Suppose the goal of the department is to maximize the discounted benefits to the students of quality of instruction net of the cost of improving instruction. In order to achieve this idealistic goal, consider the behavior of the representative faculty member of the department who chooses a combination of two streams of human capital investment, i_1 (research) and i_2 (pedagogical training), to maximize

$$\int_{T_0}^{T_1} e^{-rt}[B(x(t)) - C(i_1, i_2)]dt$$

subject to

$$\dot{x}(t) = i_1 + i_2 + ai_1 i_2 - bx, \qquad x(0)=x_0>0,\ i_1 \geq 0 \text{ and } i_2 \geq 0,$$

where B(x(t)) is the benefits to students, x(t) is the instructor's human capital, and $C(i_1, i_2)$ is the department's cost of improving instruction. Note that a dot over a variable indicates a derivative with respect to time. From the state equation, $\dot{x}(t) = i_1 + i_2 + ai_1 i_2 - bx$, the faculty member affects his or her human capital by investing in research and/or pedagogical training such as TQM. Depending on the types of institution, i_1 may include publications in refereed journals, publications in proceedings or books, or presentations at meetings. From the perspective of improving teaching, "unsuccessful" research that is not published may provide benefits if it allows the instructor to keep current in the field. Also note that human capital is assumed to decay at a constant proportion, *b*. Paul and Rubin (1984) note that human capital associated with graduate level training in economics decays over time and publications act as a signal of human capital. They provide support for rewarding research at colleges and universities where teaching is the primary mission This decline in human capital may be attributed to memory loss or the loss of relevancy of human capital due to the changes in the field. The positive coefficient, *a*, reflects a complementary interaction term between the two forms of investment. The faculty member's investment in research positively affects his or her investment in teaching skills; similarly, pedagogical training spills over to the instructor's research. If a is zero, investment in pedagogical training and research are independent activities; there are no spillover effects in which research activity improves an instructors teaching or vice versa. This may occur, for example, if the faculty member engages in repetitive research in which he or she publishes multiple papers on the same subject with only nominal changes between papers.

The Hamiltonian associated with the department's goal of maximizing the discounted benefits to the students net of the cost of improving instruction is

$$H=e^{-rt}[B(x)-C(i_1, i_2)] +L(i_1 + i_2 + a\, i_1 i_2 -bx). \qquad (1)$$

The necessary first-order conditions are

$$\partial H/\partial i_1 = -e^{-rt}\ \partial C/\partial i_1+L+Lai_2=0, \qquad (2)$$
$$\partial H/\partial i_2 = -e^{-rt}\ \partial C/\partial i_2+L+Lai_1=0, \qquad (3)$$
$$\partial^2 H/\partial i_1^2= -e^{-rt}\ \partial^2 C/\partial i_1^2 <0, \qquad (4)$$
$$\partial^2 H/\partial i_2^2= -e^{-rt}\ \partial^2 C/\partial i_2^2<0, \qquad (5)$$

and

$$\partial L/\partial t= -\partial H/\partial x=-e^{-rt}\ \partial B/\partial x +bL. \qquad (6)$$

An important policy regarding the allocation of resources originates from equations (2) and (3), since the discounted marginal cost of investment must equal the direct marginal benefits of the investment in research plus the indirect marginal benefits. The standard interpretation of L is the marginal valuation or shadow price of the state variable (see Chiang, 1992; Kamien & Schwartz 1991; Léonard & Van Long 1992). Specifically, equation (2) states that the discounted marginal cost of investment in research, $e^{-rt}\ \partial C/\partial i_1$, must equal the marginal benefits of human capital investment from research, L, plus the indirect spillover benefits from this type of investment, ai_2, as suggested by Paul and Runbin,1984 and Oakley,1997. The interaction between the two forms of investment allows the marginal cost of investment in research to exceed the marginal valuation of human capital due to the investment in research. A similar interpretation for i_2 arises from condition (3). Conditions (4) and (5) are satisfied by assuming an increasing marginal cost of investment for each type of investment.

Subtracting bL from both sides of (6) and multiplying by the integrating factor e^{-bt}, and then integrating yields

$$e^{-bt} L = \int_{T_0}^{T_1} e^{-(r+b)s} \frac{\partial B(x(s))}{\partial x} ds. \tag{7}$$

Multiplying by both sides of (2.7) by $e^{(r+b)t}$ yields

$$e^{rt} \lambda(t) = \int_{T_0}^{T_1} e^{-(r+b)(s-t)} \frac{\partial B(x(s))}{\partial x} ds. \tag{8}$$

From (2), note that $e^{rt} L = (\partial C/\partial i_1)/(1+ai_2)$. Substituting this expression into the left hand side of (8) yields

$$\frac{\partial C}{\partial i_1} = (1 + ai_2)\int_{T_0}^{T_1} e^{-(r+b)(s-t)} \frac{\partial B(x(s))}{\partial x} ds. \tag{9}$$

Equation (8) implies that the optimal path of investment in research requires that the marginal cost of the investment equals the marginal benefit of investment. The marginal benefit of investment from research has two components: the discounted stream of marginal benefits to the students plus an additional fraction of that discounted stream due to the complementary interaction of the two forms of investment. Analogous conditions exist for the optimal investment in pedagogical training.

Authors such as Anderson (1992) and Sykes (1990) have reinforced the perception that teaching and research are incompatible activities. Yet others such as Oakley (1997) argue that there exists a positive relationship between teaching effectiveness and scholarly activities. The preceding model provides a formalization of the positive interaction of teaching and research as discussed by Oakley (1997). Contrary to the “flight from teaching” belief, where research productivity occurs at significant sacrifice in terms of teaching, the solution of the optimal control problem suggests that research gains spillover to teaching in a complementary manner.

Of course, the motives of the individual may be significantly different from the goals of the institution. For analysis of the institution’s perspective, see McPherson and Winston (1983) and Carmichael (1988). As is well-known, the anecdotal evidence suggests that the untenured faculty member is primarily concerned with obtaining tenure, and Hamermesh (1992) argues that a major reason for denying tenure to assistant professors is the lack of publications associated with a slow start. He notes, "Committee work, lecture preparation and advising can quickly fill your schedule." Boyes et al. (1984) find variance in the returns to research depending on the size and rank of the university. Given the reward structure at a university that values both teaching and research, is engaging in pedagogical training incentive compatible? In the next section, we use a signaling model to analyze this issue.

A SIGNALING MODEL

In a signaling framework the faculty member engages in human capital investment, i, in order to receive tenure. Our objective is to analyze a game in which the administrator has incomplete information about the ability or work ethic of the untenured faculty member. This is a variation of Spence's signaling model. Signaling models have been used to address a wide range of problems from transboundary pollution (Chambers & Jensen, 2002) to draft selection in the National Football League (Conlin, 1999). For a brief introduction to a signaling model similar to Spence (1974), see Fudenberg and Tirole (1992) or Osborne and Rubinstein (1994). Harsanyi (1967, 1968a, 1968b,1995) provide a more general introduction to games with incomplete information. Private information exists regarding the ability or work ethic since the faculty member knows his or her type and the administrator is uncertain. We assume that, depending upon these factors, the faculty member can be either a "low talent" or a "high talent" individual. For simplicity, assume that both types receive similar teaching evaluations from students. Note that there is some debate about the use of student evaluations in the tenure decision. Some researchers argue that, while they can accurately measure an instructor's communications skills, students lack the background necessary to judge whether they are being taught accurate, relevant information (see Abrami, Leventhal & Perry, 1982; Naftulin, Ware & Donnelly,1973). Thus it is possible for instructors with varying levels of investment in human capital (research) to receive similar teaching ratings from students. We model these two types by assuming that there are two possible talent parameters, T^L for the low type and T^H for the high type. Each type chooses a level of human capital investment, i, where the cost of a unit of human capital investment is i/T^f for each faculty member type, f=L or H. For simplicity, we initially assume that each type of human capital investment is equally valued, so that total observed human capital investment is $i=i_1+i_2$. We assume that each type of human capital investment is completely observed. Also note that the signal does not involve the interaction term. Since $T^L < T^H$, it is easier for the high type to obtain higher levels of human capital investment and; therefore, the high type is more likely to receive tenure. Given that the administrator is concerned with providing quality teaching, which is a function of human capital investment, the administrator responds to the higher levels of human capital investment by providing higher tenure evaluation scores, *s*.

To analyze the administrator's problem, assume for the moment that he or she knows the type of the faculty member with certainty. As compared to the environment with uncertainty, this problem is greatly simplified, since the administrator chooses a level of tenure recommendation to maximize the quality of teaching following a simple decision rule. The high types are rewarded with tenure and the low types are denied tenure. Although the faculty member types' are known in this scenario, the faculty members engage in human capital investment since the normal duties of the job and renewal prior to the tenure decision required this activity. For simplicity, suppose there exists a faculty member who is the low type and is only able to obtain a human capital investment level of i^L. In terms of obtaining tenure at this university, this level of investment is almost irrelevant since it contains no signaling value given that the type is known. This is assuming that the human capital investment is not specific to the university in question and, therefore, the human capital investment is a valuable signal for the employment search after tenure is denied. It follows that the faculty member receives a tenure score of s^L and tenure is denied. Similarly, if it is known that the faculty member is a high type and chooses a human capital investment level of i^H in the process of meeting the normal job requirements, the resulting tenure score is s^H and tenure is granted. In this framework where the administrator knows the faculty type with certainty, the human capital investment is not required as a signal for tenure purposes but is a result of fulfilling normal job requirements.

In the uncertain environment, we assume that the administrator's tenure decision minimizes the quadratic difference between the tenure score, s, and the faculty member's talent, T. The objective function in the form of quadratic difference, such as $(s-T)^2$, is a standard approach in signaling models (for example, see Fudenberg and Tirole, 1992; Osborne and Rubinstein, 1994). The administrator's expectation of the quadratic difference is minimized if $E(T)=s$. With this objective function and the administrator's belief that the faculty member is the high type, the faculty member receives the high evaluation score, s^H. Conversely, if the administrator believes that the faculty member is the low type, the faculty member receives the low evaluation score, s^L. The prior probabilities are given by p^L for the low type and p^H for the high type.

To signal his or her type, the faculty member chooses the costly activity of human capital investment, with the cost of a unit of human capital investment equal to i/T^f for each faculty member type, f, where f = L or H. As described above, since $T^H>T^L$, it is easier for the high type to reach higher levels of human capital investment and, therefore, positively affect his or her tenure score. Given that human capital investment is costly, we assume each faculty member type's problem is to choose a level of human capital investment, i, to maximize its net benefits, $s- i/T^f$.

The administrator's problem is made more difficult in an environment with uncertainty since the low type may act strategically. In a different light, Siow (1998) provides evidence that research has a signaling role in that it attracts higher ability students. Specifically, the low type may have an incentive to camouflage his or her type if mimicking the high type's behavior is not too costly. If the low type is able to camouflage, this less productive faculty member can return to a utility maximizing lower effort once tenure is granted. Also note that the high type has no incentive to camouflage his or her type since mimicking the low type would reduce his/her probability of obtaining tenure.

We focus our attention on the two common types of equilibria: separating and pooling. First consider the possibility of a separating equilibrium. In a separating equilibrium, the faculty types "separate out" by choosing different levels of human capital investment, so the observed outcome reveals the true faculty type to the administrator. In this equilibrium, the low talent faculty member cannot mimic the higher human capital investment of the high type. In other words, the tenure requirements are too difficult for the less productive faculty member to reach. The natural separating equilibrium is one in which the high and low types use the strategies of the certainty game, i^H and i^L. A necessary condition for a separating equilibrium in which the low type does not imitate the high type is $T^L - (i^L/T^L) \geq T^H - (i^H/T^L)$. Recalling that E(T)=s, this condition states that the low type faculty's net benefits of pursuing the low human capital investment exceeds the net benefits of pursuing the more costly strategy of high capital investment. Alternatively it may be viewed as $(i^H/T^L) - (i^L/T^L) \geq T^H - T^L$ or that the low type's costs of imitating the high type, $(i^H/T^L) - (i^L/T^L)$, exceeds the benefits of imitation, $T^H - T^L$. As stated earlier, the high type has no strategic incentive to imitate the low type. More formally, this condition is $T^H - (i^H/T^H) \geq T^L - (i^L/T^H)$. In other words, the high type's net gains from choosing the high human capital investment is greater than the net benefits from a strategy of low human capital investment. Alternatively, this condition may be expressed as $T^H - T^L \geq (i^H/T^H) - (i^L/T^H)$, which implies the high type's reward to the strategy of $i=i^H$, the acquisition of a favorable tenure review, is greater than the cost of acquiring this score.

To guarantee the existence of this equilibrium, we also need a specification of the administrator's updated or revised beliefs, R(T), which are consistent with separation. A reasonable separating belief for this model is $R(T^L \mid i)=0$ if $i \geq i^H$. Under this belief, any investment equal to or greater than i^H implies the faculty member is not the low type.

Under what conditions does a pooling equilibrium, in which the low type imitates the high type, occur? First, both faculty types must choose the same level of human capital investment. In such an equilibrium, one faculty type imitates the other by choosing the same level of human capital investment, so the administrator's uncertainty about the faculty type persists and he/she is unable to update his/her prior probabilities.

A necessary condition for a pooling equilibrium in which the low type imitates the high type or $T^H - (i^H / T^L) \geq T^L - (i^L / T^L)$. In such an equilibrium, the low faculty type imitates the high by choosing the same level of human capital investment. The resulting tenure score, WS, is a weighted average based on the probabilities of each type, $WS = p^L T^L + p^H T^H$. In addition to the necessary condition of the low type imitating the high type, the administrator must believe that both types are high types. Suppose the observed outcome of the level of human capital investment for both types is i^H . To guarantee the existence of this equilibrium, we must specify beliefs for the administrator concerning deviations away from i^H. If any deviations away from the high level of human capital investment are made by the low type, mimicking behavior of the low type can be supported by $R(T^L \mid i)=1$ for any $i \neq i^H$. Under these beliefs, the low type can imitate the high type if and only if it chooses the same level of human capital investment. If the tenure score $WS = p^L T^L + p^H T^H$ is below a threshold tenure score, s^T, that is required for tenure, the pooling equilibrium is not a Nash.

Now consider a situation in which we make a distinction between the two types of human capital investment: research (i_1) and pedagogical training (i_2). Suppose that these two types of investment are not equally costly to the faculty members. As before, in order to receive tenure, a faculty member must engage in a certain overall level of investment, i, but now assume the faculty member must also show some balance between the two types. This is consistent with the common expectation that faculty members exhibit involvement in both research and training related to teaching in order to receive tenure. Given the cost differentials, the lower cost type of investment may represent a higher proportion of total investment. If the pedagogical training is less costly, a faculty member may devote greater time and resources to this activity. However, the external rewards of each type of investment are not equal, in that, the research published in refereed journals is more likely to have a greater market value. This increased importance of one type of investment sends an additional signal to the administrator, in that, he or she now receives information in the form of type of investment as well as the overall level of investment. A faculty member with a high overall level of investment, but with a high proportion of the lower cost form of investment may be revealing a weakness in the other area. In order to reveal such weaknesses, the administrator may impose specific criteria for each form of investment depending on the goals of the department.

POLICY IMPLICATIONS AND CONCLUSIONS

The interaction between research and teaching quality has been widely recognized and fits well with both the TQM and production function models of teaching. We have shown, using an optimal control model, that a positive interaction term between research and teaching implies that the optimal level of research exceeds the point at which the marginal cost is equal to the marginal direct benefits. While this result may seem intuitively obvious, it is often ignored in practice. Our results suggest that the optimal tenure decision at a teaching university may be based on a criteria that incorporates both pedagogical training and research. In a separate model, we consider the tenure decision as a signaling game in which there exists uncertainty regarding the quality of the faculty member. The administrator's job is complicated by the fact that, under some circumstances, the low quality faculty member may be able to camouflage his or her type and receive tenure. In this case, it may be optimal for the administrator to increase the minimum standard for tenure. If there are different costs associated with different types of human capital investment, the administrator may also choose to impose additional requirements on the type of investment.

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