Adoption of Technology-Mediated Distance Education among Higher-Education Institutions

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Extended Abstract

1 Introduction

Recent developments in Information Technology (IT) and the commercialization of the Internet have generated new opportunities for the delivery of education and allowed many higher-education institutions to bring their resources closer to a broad base of potential users. Graduate business degrees are especially in high demand; about 200 accredited schools offered Master of Business Administration (MBA) degrees over the Internet in 2002 according to the educational research firm Eduventures Inc. The population of online MBA students rose from about 5,000 students in 2000 to more than 100,000 in 2002 (Braun 2003). Enrollment at the largest U.S. online college, University of Phoenix Online, rose to around 100,000 students in 2003 and is expected to rise 50\% in 2004. Business Week ranked the online college 22nd in its 2004 Info Tech 100 list and placed it among the top 10 most profitable IT firms (Baker and Green 2004). These developments suggest that the U.S. higher-education sector is finally embracing the information age.

Despite the importance of the higher-education sector in the U.S. economy, the strategic use of technology-mediated distance education (TMDE) has received limited research attention at best. We refer to TMDE as synchronous and asynchronous instruction delivered to remote locations via a combination of computer, communication, and data management technologies. The overwhelming majority of Information Systems (IS) research on TMDE has focused largely on the student level of analysis and has provided an understanding of the critical enabling role of IT in learning environments. However, there is also a need for research that takes a broader perspective on the impact of TMDE. In their research commentary, Alavi and Leidner (1995) called for a greater depth and breadth in this area and stressed the lack of studies that focus on the organizational and program levels. As a step toward understanding the strategic impact of TMDE at a broader level, we explore the types of higher-education institutions and degree programs that are more suited to utilize the new opportunities enabled by IT. In particular, we focus on the appropriate hybrid model—part online, part traditional—that best serves the interests of an institution. We first analytically model the value of education for students who have differentiated preferences for a certain institution’s degree, and then analyze which institutional characteristics support the adoption of TMDE. The hypotheses derived from the model are tested using two separate data sets obtained from surveys of Department of Education and U.S. News & World Report.

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2 A Model of a Higher-Education Institution

Consider an institution offering higher-education at a quality level \( q \). For simplicity, the institution offers a single degree that may be interpreted either as an undergraduate or a graduate one. Potential students consider whether or not to get this single degree. In this section we model the present value of individuals’ lifetime earnings with and without the degree; the difference between the two determines the value of the degree for the potential students in the market.

Let \( a \) denote the academic abilities of the typical student enrolled at the university. Upon graduation, an individual with a degree from the institution and \( t \) years of work experience earns \( w(aq, t) \). Based on previous research on return to schooling, we assume \( \frac{\partial w}{\partial a} > 0, \frac{\partial w}{\partial t} > 0, \) and \( \frac{\partial^2 w}{\partial a \partial t} > 0 \).

The decision of each individual is whether to defer income in order to invest in human capital or to start earning income immediately. As standard in the literature, it is assumed that postponement of earnings due to schooling is tantamount to a reduction of an individual’s remaining earning span. Denoting the potential earning span by \( n \), the accumulated work experience of the typical student at the time of entering the degree program by \( z \), the required duration of studies at the institution by \( d \) (all in years), and the discount rate by \( r \), the present value of an individual’s remaining lifetime earnings after graduation is

\[
V_S = \sum_{i=1}^{n-z-d} \frac{w(aq, i + z - 1)}{(1 + r)^{i+d}},
\]

where \( z \) is the experience on completing the degree program, which can differ from the experience \( z' \) at the time of entry if the individual works during his or her studies. Let the present value of an individual’s next best alternative to earning the degree from the institution be denoted by \( V_N \). This next best alternative could be work, or it could be attending an alternative university.

Students incur the location-related expense \( L \) to attend the university. They either travel daily to campus if they live close by or they relocate to the vicinity if they are far away. Students also derive an idiosyncratic consumption value \( \alpha > 0 \) from attending the institution.\(^1\) The return to the degree is defined as the benefit of the educational experience

\[
V(\alpha) = V_S + V_T - V_N + \alpha - L,
\]

where \( V_T \) denotes earnings of students from working during the degree program given their experience level on entering the degree program equal to \( z' \). Note that the characteristics of the typical student may change depending on the type of the degree; for example, graduate degree applicants may have more work experience than undergraduate degree applicants, and it may be more likely that their next best alternative is employment.

Both the quantity and content of TMDE can vary. That is, some courses may be offered fully online while others may have only a portion of them as such. Let \( k \) denote the extent of adoption by an institution in terms of the overall proportion of instruction carried out via TMDE. TMDE can increase earnings during the degree program by allowing students to work at their outside opportunity when some courses are offered online, a benefit that we call the time flexibility of TMDE and denote with \( V_T \). In addition, by allowing experience to accumulate during the degree program, it can increase subsequent earnings by raising the experience of the degree recipient, such that \( \frac{\partial z}{\partial k} > 0 \). TMDE can also reduce location-related expenses. Consequently, \( V_S, V_T \) and \( L \) all take \( k \) as an argument. We also let the quality of education depend on \( k \) because the experience via the two modes of education may be quite different. On-campus education has such benefits as mentoring and networking with professors, learning problem-solving skills, and interacting with other students outside of classes. While the Internet allows the incorporation of some level of interactivity using chatrooms and text-based discussion forums, it lacks socialization, debates, and other social interactions needed for the development of ideas and concepts. Lack of student-teacher and student-student interaction and lack of group emphasis are all mentioned as factors that undermine the quality of education delivered from a distance. We therefore take \( \frac{dL}{dk} \leq 0 \).

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\(^1\)Higher-education is a differentiated good due to the variety of offerings. Students preference for a university is based on the characteristics of its degree programs, campus, social atmosphere, past attendance of a family member, or other factors.
The institution sets the extent of TMDE adoption and charges a tuition; individuals with a preference for the institution (high $\alpha$) and consequently a positive return net of the tuition apply. Given the capacity $E$, the institution can increase its tuition until the marginal student, the individual with the lowest $\alpha$ value ($\alpha_{\text{min}}$) among all students, is indifferent between attending the institution and the next best alternative, defined as $V_{\text{N}}$. The tuition thus equals

$$ p(\alpha_{\text{min}}, k) = V(\alpha_{\text{min}}, k) = V_S(k) + V_T(k) - V_{\text{N}} + \alpha_{\text{min}} - L(k). \quad (2) $$

Taking as given the current enrollment, the problem of the institution is to select the level of TMDE adoption that maximizes the net return from the marginal student. This objective may appear as a strong assumption at first sight, considering the many non-profit institutions in the higher-education sector. Another objective would be to maximize enrollment, in which case one would also have to consider the effect of a change in $k$ on potential students not currently attending the school. Note that actions that increase the net return can be viewed as similar to activities that increase enrollment in the sense that, if the school were to return the increase in tuition that the marginal student is willing to pay to all students, this lower effective tuition would attract additional students. Hence, both approaches would yield similar results.\(^2\)

The institution’s problem is

$$ \max_k \Pi \equiv p(\alpha_{\text{min}}, k) \cdot E - C(k) $$

subject to $k \in [0, 1]$, and where $C$ is the total cost of operation. Assuming an interior optimal solution for the extent of TMDE adoption ($0 < k^* < 1$)\(^3\), we find the following relationship from the first-order condition of this optimization problem\(^4\)

$$ \sum_{i=d+1}^{n-2} \frac{1}{(1+r)^i} \left( d \frac{dw}{dq} \frac{dq}{dk} + d\beta \frac{dw}{dt} \right) + \frac{dV_T}{dk} - \frac{dL}{dk} = \frac{1}{E} \frac{dC}{dk}. \quad (3) $$

A number of implications are in order. First, the value of $\frac{dq}{dk}$ can be significantly more negative for a top-notch school, which may find it much harder to differentiate its TMDE courses and offer a value similar to what it can on-campus. Second, the inability to deliver an educational experience similar to the one on-campus via TMDE ($\frac{dq}{dk} < 0$) hurts an institution with good students (high $\alpha$) more because a more able student body is more sensitive to quality changes. And third, since the value of time flexibility of TMDE increases with already accumulated work experience $z'$, the institution becomes more interested in TMDE when the potential student population has considerable work experience.

\section{3 Hypotheses}

Four hypotheses on TMDE adoption are derived based on equation 3.

Institutions’ interest in TMDE will be limited if their students are academically able and they have extensive resources on campus in the form of labs, libraries, professors, etc. Note that such characteristics also increase the ranking of an institution. For example, student quality, faculty resources, and financial resources are among the inputs of U.S. News surveys. Thus:

Hypothesis 1. Controlling for size, institutions with higher rankings have lower enrollment in TMDE courses than those with lower rankings.

\(^2\)A third alternative objective, quality maximization, is also reasonable given the importance of reputation in the sector. The institution never adopts TMDE when maximizing the quality of education is the sole objective. The current form allows the analysis of the optimal level of adoption based on the benefits and setbacks of TMDE and takes into account university administrators’ reputation concerns by explicitly addressing TMDE’s effect on the quality of education.

\(^3\)While corner solutions are possible, studying only the interior solution serves the purpose of deriving testable hypotheses on TMDE adoption.

\(^4\)All arguments are dropped for notational simplicity.
Public/private status can be another proxy of quality because the educational experience at private and public schools can be quite different even if they have similar resources. Receiving support from state and local governments force public universities to pack more students into classrooms. Therefore, to the extent that the interaction with professors improves the quality of education, adoption of TMDE degrades quality less at public universities, allowing them to charge a similar tuition for a hybrid degree. On the other hand, online education would be a major change for students at private universities who are accustomed to interact with their professors in small classrooms. We therefore have the following hypothesis:

Hypothesis 2. Controlling for size, public institutions have higher enrollment in TMDE courses than their private counterparts.

The incorporation of TMDE into the curriculum increases $V_T$ by allowing students to work, which can, in turn, increase the value of the degree $V$. Experienced individuals have less to gain from education and more to lose from skipping work for it because the remaining lifetime earnings decrease and yearly earnings increase with experience. Therefore, the time flexibility of TMDE benefits working adults and mid-career individuals more, who may have better opportunities than just investing in their human capital. We expect experienced individuals with high salaries (e.g., upper-rank executives) to be more interested in graduate degrees because such individuals typically have an undergraduate degree already. We thus have the following hypothesis:

Hypothesis 3. Controlling for size, institutions committed to both graduate and undergraduate education use TMDE more in their graduate programs.

Since regional institutions typically receive the majority of the applications from their own region, travel-related savings are a major benefit for their student body. Population density of each state can serve as an imperfect measure of mean travel-related expenses of students if the number of students per school across states is assumed to be the same. The lower the population density is, the longer is the mean driving distance to campus in that state, and the more benefit TMDE offers to students (a more negative $\frac{dL}{dx}$). Therefore, regional institutions should be more interested in TMDE when the state has a low population density than when it does not.

Hypothesis 4. Controlling for size, regional schools in states with low population densities have higher enrollments in TMDE courses.

4 Empirical Analysis

The dependent variable of our data set, enrollment in credit-granting TMDE courses, comes from two nationally representative surveys of distance education undertaken by the National Center for Education Statistics (NCES). Part of the Postsecondary Education Quick Information System (PEQIS) of NCES, the surveys provide information about the 12-month 1997-1998 and 2000-2001 academic years. The first PEQIS survey employs a standing panel of 1,669 postsecondary education institutions while the second one has 1,600. The panels include institutions at the four-year, two-year, and less-than-two-year level, public and private colleges, and universities that award associate, bachelor’s, master’s, and doctoral degrees. The inclusion of various types of institutions reflects the exceptionally complex nature of the U.S. higher-education sector and its multitude of products. The standard Carnegie classifications are used to manage this complexity; that is, tests are run for schools in each category, including national (doctorate-granting) institutions, regional (master’s level) institutions, liberal arts and baccalaureate colleges, and two-year and less-than-two-year schools. Carnegie classifications as well as institutional characteristics such as public/private status, enrollment levels, and revenue sources are obtained from the Integrated Postsecondary Education Data System (IPEDS). IPEDS is the core postsecondary education data collection program for NCES and is built around a series of interrelated surveys to collect institution-level data in such areas as enrollments, program completions, faculty, staff, and finances. The 1997 and 2000 U.S. News & World
Report rankings are used as proxies for quality. Published in 1996 and 1999, these are the most recent rankings that could be used by applicants of the 1997-1998 and 2000-2001 academic years. Finally, data on population and area of each state is obtained from the U.S. Census Bureau.

We observe that 49 and 26 percent of the schools in the samples did not offer any TMDE course during the 1997-1998 and 2000-2001 academic years, respectively, which constitute corner solutions for the decision variable $k$ in our model. We therefore test our hypotheses using the standard censored Tobit model, also known as the corner solution model. Censored Tobit is the default model used in corner solution applications and is estimated by many software packages (Wooldridge 2002).

The empirical results support the hypotheses. First, controlling for other explanatory variables such as size, universities designated to be in the top tier by U.S. News have fewer enrollment in TMDE courses. Second, public status positively affects TMDE enrollment at national institutions, baccalaureate colleges, and two-year and less-than-two-year colleges. Third, institutions adopt TMDE more to their graduate programs, a significant difference with less than 1% p-value. And fourth, population density correlates significantly (and negatively) with enrollment in TMDE courses at only regional institutions for the 1997-1998 academic year, while the correlations are significant at all categories except liberal arts and baccalaureate colleges for the 2000-2001 academic year. The last two results are in line with past research that mention time and location flexibility as two important benefits of TMDE (Zhang et al. 2004).

5 Summary and Conclusions

IS research on distance learning have primarily focused on the comparison of TMDE and non-TMDE environments but largely ignored the program and university level of analysis (Alavi and Leidner 2001). To extend the literature to this level, we focus on the optimal program design as a function of institutional and student market characteristics. We also explore the state of TMDE use among U.S. higher-education institutions and observe that the advantages and disadvantages of TMDE as reported in the literature drive adoption patterns. Our empirical investigation supports the main hypotheses of the model, including the significance of the quality of education on campus and the effects of time and location flexibilities of TMDE in driving adoption.

We expect the results to be of most value to academic administrators who face the problem of designing a hybrid degree. Our framework provides a list of important things to consider: What is the quality of your education on campus? Can you offer some of the classes from a distance using IT without sacrificing much from that quality, and at what cost? What are the characteristics of your student body, and how much would they value the time and location flexibility of TMDE? A rigorous treatment of these questions will help academic administrators design hybrid programs that would benefit both their institutions and their students.

References


