Competition, Selectivity and Innovation in the Higher Educational Market

August 2014

Preliminary Draft Not to be Quoted Without Permission From Authors

ABSTRACT

Recent innovations in digital learning and web-based technologies have enabled scalability in educational services that has previously not been feasible presenting a potential disruption of traditional higher education markets. This paper explores the impact of these innovations in vertically differentiated market with network externalities. Students differ in their ability to benefit from educational services. We describe how selective and non-selective institutions compete for students though tuition price and admission criteria and consider how free non-credentialed educational services (MOOCs) affect the market equilibrium. Our model also helps explain why selective institutions are frequently also the proprietors of MOOCs.

JEL Codes: D43, I23
Key Words: Higher Education, Vertical Differentiation, Network Effects
1. Introduction

Recent innovations in digital learning and web-based technologies have enabled scalability in higher educational services far beyond what had previously been considered feasible. As a result, many commentators forecast this technology to have a comparable disruptive impact on the traditional brick and mortar college market that web-based information provision has had on print media and the music industry. Of particular interest in this respect have been the web-based platforms known as Massive Open Online Courses, (MOOCs). MOOCs typically employ the services of faculty from some of the most selective four-year institutions to provide high quality presentation of academic material while offering access to that material without regard either to economic, geographical or demographic constraints.²

This paper derives a simple but novel model of the higher education market that casts light on the MOOC phenomenon. We develop a vertically differentiated but parsimonious framework that captures the role of selectivity in the higher education market. In our model, a selective institution is characterized by a negative externality, whereby the value of its degree declines as its enrollment grows. This is not the case for the degree of the alternative nonselective institution. Our model also incorporates key elements emphasized by Hoxby (2014).
Specifically, selectivity leads to higher value added in the education services provided, which in turn gives rise to additional revenue streams from alumni donations and grant funding.

Selective institutions differ from nonselective institutions regarding the institution’s research mission. Central to the mission of the selective institution is the creation of knowledge or research. This is not the case for the nonselective institution. Nevertheless they share a common market of students, and both are affected by recent educational innovations that may be an alternative to an accredited degree. Our model illuminates this impact. It also offers some insight regarding the motivation of the most selective institutions to offer MOOC classes.

2. A Vertically Differentiated Model of the Higher Education Market

The higher education sector features extensive product differentiation, of which there is a significant degree of horizontal differentiation. For example, schools differ in size, location, whether they offer a liberal arts or more specialized undergraduate education. There is however an important vertical dimension to differentiation in higher education. In particular, there are some widely-recognized top quality and highly ranked research institutions that tightly screen their students for admission. In this paper, we focus on this vertical dimension and limit the types of institutions to two that we refer to as a high quality and lower quality institution. While this is a simplification it is a useful one that permits some key insights regarding the recent advances in educational technology.

High quality or top ranked research institutions are distinguished by the fact that they create knowledge as well as disseminate knowledge. That is, such schools are top research institutions and they invest heavily in their research infrastructure. These schools also invest heavily into each student that they educate. While it is widely recognized that the full tuition at many higher educational institutions is likely less than the full cost to educate a student, Hoxby (2014)
provides evidence that this is particularly true at highly selective private institutions in the U.S. In turn, this implies that top ranked research institutions depend heavily on grant and endowment income to fund their research activities. This helps to explain why private doctoral universities hold roughly 43 percent of total endowment assets among all universities and why over three-fourths of that amount is concentrated among the top ten ranked Ph.D. research universities.³

Lower ranked and less selective institutions, on the other hand, are more in the business of disseminating knowledge. They offer or sell to their students more standardized educational services. Hoxby (2014) reports that a non-trivial share of the courses taught at non-selective institutions in the US cover the same material that appears in secondary school curricula. Pre-set state subsidies can be important for such institutions but at the margin, funding is driven by tuition revenues, and these are increasingly important overall in covering the costs.

Attendance at a selective institution yields significant financial gains relative to attendance at a non-selective school. Brewer, Eide, and Ehrenberg (1999) and Hoxby (2001) use large national data sets to find a wage-premium for attending a selective college that may have grown over time. Black and Smith (2006) find a smaller but still statistically significant selectivity premium using NLYS79 data, while Hoekstra (2009) uses a regression discontinuity approach and finds a significant and larger selectivity premium. The well-known exception to the general finding of a selectivity premium is of course Dale and Krueger (2002, 2011) who find no financial advantage to attendance at a more selective institution. However, they are also unique in employing a data set consisting only of students at selective colleges and controlling for the schools to which an individual was accepted. Black and Smith (2004) on the other hand use a propensity score

matching approach and find a wage premium of 11 percent for men and 7.5 percent for women who attend a selective school.

Further evidence of the financial advantage of attending a selective school is provided by Rivera (2011) who documents that the most prestigious firms and the most prestigious graduate schools recruit almost exclusively from the most selective undergraduate institutions. This work builds on the earlier work of Useem & Karabel (1986) showing that a disproportionate number of Fortune 500 CEOs graduate from the most selective institutions. More recently Hershbein (2013) uses national data covering five decades to find a wage premium of seven to fourteen percent from attending a selective institution. Note as well that the foregoing evidence on financial gains typically is based on wage or income data. Yet there may well be other advantages to going to a selective school that, though non-pecuniary in nature, nonetheless can be given a dollar value. These include better health, lower divorce probability, and greater job satisfaction, among others, (Oreopoulos and Salvanes, 2011).

An important source of the student’s gain from pursuing a research-based curriculum at a selective institution appears to be “peer effects”. Endogeneity issues such as selection bias and the separation of individual from group effects have made it difficult to measure the importance of peer effects empirically. However, recent studies using unique data sets (Ding and Lehrer, 2007 and Carrell, Fullerton and West, 2008) have found evidence of sizable and robust peer effects in education.

In this connection, it is important to recognize that students differ in their preparation and their talent for learning college-level material. Some students are either better prepared and/or have a greater natural ability to benefit from university education. Observed peer effects reflect the fact that as an institution becomes less selective, its admitted population increasingly includes less
talented or prepared students and this reduces the quality of the education overall. The “whole” of bringing together a select group of highly motivated and talented students is greater than the “sum of its parts”, but this effect decreases as selectivity decreases. The studies referenced above also suggest that high ability students benefit more from having less variation in peer quality. It is important therefore for the costly selective institution to screen and enroll only those students with high aptitude for and ability to benefit from a research-based higher education.

A realistic model of the U.S. higher education market should include selective and non-selective institutions, each having different business plans regarding the role of endowment funds and tuition revenues. These institutions must also compete to enroll students of heterogeneous ability in realizing the gains from university-level education. Finally, the model must allow for the role of peer effects at a selective institution. In other words the value of the education offered at a selective institution declines as the average student quality at the school also falls.

In this paper we consider a duopoly model with two kinds of higher educational institutions: a high quality one, $I_1$, and a lower quality one, $I_2$, each offering an accredited higher education credential. There is a population of $N$ students who are choosing whether or not to pursue a higher education credential at an accredited institution. Students differ in their academic preparation, their motivation and their ability to learn, and it is these characteristics that together determine the student’s likelihood of success or benefit from obtaining a higher education degree. Denote by $\theta_i$ the likelihood that student $i$ is able to derive benefit $V_1$ from the high quality institution, or benefit $V_2$ from the lower quality institution. The parameter $\theta$ is assumed to be uniformly distributed over the population of $N$ students in the interval $[0,1]$.

Let the expected utility of a student $i$ attending a high quality institution and incurring tuition cost $t_1$ net of any scholarship funding be:
Where $\hat{X}_1$ is the expected number of credentials or degrees conferred at the high quality institution. The greater is the number of degrees conferred at the high quality institution, the less selective it is, and the lower is the average student quality, which in turn, weakens the academic quality and the “peer effects” of the institution. The parameter $\alpha$ is a measure of the importance of the externality associated with selectivity, or the importance of the “peer effect” on academic quality. The term $\alpha \hat{X}_1$ measures how a decrease in selectivity adversely affects the student’s expected gain from attending a high quality institution. The higher is the parameter $\alpha$, the more weight is given to selectivity of the high quality institution. This in turn makes the expected value of attending a high quality institution less attractive for students with lower values of $\theta$.

The expected utility of attending a lower quality institution at tuition cost $t_2$ is:

$$U_i = \theta_i V_2 - t_2$$

We assume without loss of generality that $V_1 = 1$ and $V_2 = \nu$, where $\nu < 1$. This normalization assumption implies that the parameter $\alpha$, which measures the externality associated with selectivity, is such that $\alpha < 1$. In addition we set the population of potential students $N = 1$.

Denote by $\hat{\theta}_1$ the student who is just indifferent between attending the high quality and the lower quality institution, and by $\hat{\theta}_2$ the student who is just indifferent between enrolling in a low quality institution and not pursuing a higher education credential. The following conditions define these marginal consumers of higher education accredited degrees:

$$\hat{\theta}_1 - \alpha \hat{X}_1 - t_1 = \hat{\theta}_1 \nu - t_2$$

$$\hat{\theta}_1 - \alpha \hat{X}_1 - t_1 \geq 0$$

$$\hat{\theta}_2 \nu - t_2 = 0$$
Given the assumptions of a uniform distribution of $\theta$ and $N = 1$ the demand functions facing the high quality and low quality institutions are given by:

$$X_1(t_1, t_2) = [1 - \hat{\theta}_1(t_1, t_2)]$$

$$X_2(t_1, t_2) = [\hat{\theta}_1(t_1, t_2) - \hat{\theta}_2(t_2)]$$

(4)

We assume that students have rational expectations about the enrollment of institutions, which as in Grilo, Shy and Thisse (2001), is equivalent to assuming that the institutions announce and commit to their net tuition charges, $t_1$ and $t_2$.

Let the marginal cost $c$ of supplying a student credential be constant and the same at both types of institutions. For simplicity, we set $c = 0$. However, both schools have fixed costs. At the lower quality school, these costs reflect long term contracts for faculty and classroom facilities. At the high quality institution, fixed costs are much higher, reflecting the higher percentage of tenured or long contracts for faculty and the substantial and high fixed costs associated with maintaining a modern research infrastructure.

Both schools need to generate revenue to cover their costs. Yet while the lower quality school relies totally on tuition revenue, we assume that the high quality school also has access to donation and grant income.\footnote{To the extent that $D(\hat{\theta}_1)$ reflects government or research grant funding or charitable giving by foundations, students can do not consider it a fee when deciding to enroll in an elite institution.} The external funding at a high quality institution, whether alumni donations or grant funding, depends on the quality of its student body. The higher is the quality of student body at the high quality institution the higher the social return from investing in the institution’s research activities. Similarly, alumni are willing to give more back to a school the better the education value they received, or alternatively, the more they believe that the institution positively impacted their earnings. We denote by $D(\hat{\theta}_1)$ the present value of external funding at the high
quality institution and assume that \(D(\hat{\theta}_1) = \hat{\theta}_1 D\). This is the simplest functional form that captures the critical feature that grants and alumni donations depend upon the average quality of the student body at a top quality institution. The maximum value of attending a high quality institution is \(V_1 = 1\), and so we assume that \(0 < D < 1\).

The high quality institution chooses its net tuition charge \(t_1\) to maximize tuition revenue plus the present value of donation and grant revenue:

\[
\max_{t_1} t_1 \left[1 - \hat{\theta}_1(t_1, t_2)\right] + \hat{\theta}_1(t_1, t_2) D
\]

By assumption, the lower quality institution does not receive donations or grant income. Instead its goal is to maximize tuition revenue. That is the lower quality institution chooses \(t_2\) to:

\[
\max_{t_2} t_2 \left[\hat{\theta}_1(t_1, t_2) - \hat{\theta}_2(t_2)\right]
\]

This leads to the following set of best response functions:

\[
t_1^* = \frac{(1 + D - v + t_2)}{2}
\]

\[
t_2^* = \frac{(\alpha + t_1)v}{2(1 + \alpha)}
\]

Figure 1 provides an illustration of the best response function and the tuition price equilibrium. The negative consumption externality affecting student quality at the high quality institution and the grant and donation revenue, also dependent upon student quality, together lead to an outcome notably different from the standard vertically product differentiated model pioneered by Mussa and Rosen (1978), Gabszewicz and Thisse (1980), and Shaked and Sutton (1982). A rise in the value of the grants and donations revenue stream—a rise in the parameter \(D\)—shifts the best response function of the high quality institution outward, and raises the equilibrium net tuition for both schools.

Somewhat similarly, the fact that \(1 > t_1 > 0\) always implies that increasing the peer effect parameter \(\alpha\) shifts the best response function of the low quality institution up and also makes it
flatter. This again raises the equilibrium net tuition of both schools. The underlying intuition is that both higher $D$ and higher $\alpha$ increase the value of selectivity or lower enrollment at the top quality school, thus making the lower quality institution less price aggressive and this softens tuition competition between the two institutions. In contrast, increases in the value of the education provided by the lower quality school, or the parameter $v$, has a complicated impact on both best response functions that does not lend itself to straightforward comparative statics.

In equilibrium the institutions set net tuition:

$$t_1^* = \frac{2[(D+1)(1+\frac{v}{\epsilon})]}{4(1+\frac{1}{\epsilon})} \frac{v}{\epsilon}$$  \hspace{1cm} (8)
\[ t_2 = \frac{v[2 + 1 + D - v]}{4(1 + ) v} \]  

(9)

As just noted, inspection of equations (8) and (9) confirms that: \( \frac{t_1^*}{t_2^*} > 0; \frac{t_2^*}{t_1^*} > 0; \frac{t_2^*}{D} > 0; \frac{t_1^*}{D} > 0. \)

We may now identify the marginal student at the high quality institution and the marginal student at the lower quality institution. These are defined by the following:

\[ q_1^* = \frac{2 + 1 + D - v}{4(1 + ) v} \]  

(10)

\[ q_2^* = \frac{2 + 1 + D - v}{4(1 + ) v} \]  

(11)

For both institutions to have a positive market share in equilibrium, it follows that \( 1 > \hat{\theta}_1^* > \hat{\theta}_2^* > 0. \) For all parameter values of selectivity \( 0 < \alpha < 1 \) and donations \( 0 < D < 1, \) and for all values of the quality of the nonselective institution \( 0 < v < 1, \) it is straightforward to show that \( \min[\hat{\theta}_1^*, 1] > \hat{\theta}_2^* > 0, \) or the lower quality institution always has a positive market share or enrollment in any market outcome. However, in order for the high quality institution to have a positive market share or for \( 1 - \hat{\theta}_1^* > 0, \) the quality or value of the credential offered by the nonselective institution, \( v, \) must be bounded such that \( 0 < v < \hat{\theta}_1(\alpha, D) = \frac{2(1 + \alpha)(1-D)}{2-D+\alpha}. \) If the value of non-tuition income \( D \) is sufficiently low relative to \( \alpha \) such that \( D \leq \frac{\alpha}{1+2\alpha} \) then \( \hat{\theta}_1(\alpha, D) \geq 1 \) and the high quality institution always has a positive market share, or always enrolls students. This would of course be the well known outcome in the standard vertically differentiated model with \( \alpha = D = 0. \) However, when \( D > \alpha/(1+2\alpha) \) we have that \( \hat{\theta}_1(\alpha, D) < 1. \) In this case, the high quality institution will have a positive market share only if the basic value \( v \) offered by the non-selective institution satisfies \( 0 < v < \hat{\theta}_1(\alpha, D). \)
Increases in the value of endowment and grant funding or the parameter $D$ soften tuition competition between the two types of institutions. Hence, the marginal student at the top institution $\hat{\theta}_1^*$ and the marginal student at the lower ranked institution $\hat{\theta}_2^*$ both increase and less of the total student population is served, or goes on to acquire an accredited higher education credential. Similarly increases in the selectivity parameter $\alpha$ have the same effect on increasing the marginal student at each institution, again leading to a lower share of the total student population earning a credential. That is:

$$\text{For all } 0 < v < 1, \frac{\partial \hat{\theta}_i}{\partial \alpha} > 0, \frac{\partial \hat{\theta}_i}{\partial D} > 0, i = 1,2. \quad (12)$$

In equilibrium, the tuition charges set by the institutions are such that the top ranked institution always sets the higher fee, $t_1^* > t_2^*$, when the value of the credential $v$ provided by the lower ranked institution is such that $0 < v < \tilde{\hat{\theta}}_2(\alpha, D)$. When the quality of the lower ranked credential is greater than $\hat{\theta}_2(\alpha, D)$, then the high quality institution can attract high-quality students only by charging them a tuition fee $t_1^* \leq t_2^*$. We note that for values of the selectivity parameters for which $\hat{\theta}_1(\alpha, D) < 1$, the condition $0 < v < \hat{\theta}_2(\alpha, D)$ is always satisfied and condition for the high quality institution to set a higher tuition price is satisfied in this region of the parameter space.

Finally, observe that the share of the potential student population served by the higher quality selective institution $I_1$ will be less than the share served by the nonselective institution $I_2$, or $0 < 1 - \hat{\theta}_1^* < \hat{\theta}_1^* - \hat{\theta}_2^*$, when the value of the credential offered by the non-selective institution is sufficiently high such that $v > \hat{\theta}_3(\alpha, D) = \frac{1-3(1+\alpha)D-\alpha(1+2\alpha)}{1-D}$. This condition must be satisfied for the higher quality institution to be more selective in terms of number of students enrolled.

We define a selective equilibrium outcome in this market for higher as follows:
**Definition:** A selective market outcome in higher education is defined as one in which the high quality institution enrolls a smaller but positive share of the student population, 

\[ 0 < 1 - \hat{\theta}_1 - \hat{\theta}_2, \] at a higher tuition price \( t_1^* > t_2^* \), than the lower quality institution.

The regions of the parameter space \( \alpha, D \) in Figure 2 help identify the conditions for an equilibrium to be selective. Region A, bounded by the downward-sloping curve, is the area for which the parameter values are such that \( \hat{\nu}_3 (\alpha, D) > 0 \). This means that for all feasible combinations of the selectivity parameters, \( \alpha, D \), outside of the region A, \( \nu > 0 \geq \hat{\nu}_3 (\alpha, D) \). This is a necessary condition for the lower ranked institution to enroll in equilibrium more students than the top ranked institution.

For the high quality institution to have a positive market share we know that in addition to \( \nu > \hat{\nu}_3 (\alpha, D) \) the educational value of the lower quality institution \( \nu \) must also be such that \( 0 < \nu < \hat{\nu}_1 (\alpha, D) \). This condition always holds in the region of the parameter space below the line identified by \( \beta \), which describes the values of \( \alpha, D \) for which \( \hat{\nu}_1 (\alpha, D) = 1 \).\(^5\) Thus, the region B identifies values of the parameters \( \alpha, D \) such that \( \hat{\nu}_1 (\alpha, D) > 1 > \nu > \hat{\nu}_3 (\alpha, D) \).

For parameter values \( \alpha, D \) above the \( \beta \) line, identified by region C, the condition \( 0 < \nu < \hat{\nu}_2 (\alpha, D) \) is always satisfied and so condition for the selective institution to set a higher tuition price holds in this region of the parameter space. However, in the region C we must ensure that the quality of the lower ranked institution is such that \( \nu < \hat{\nu}_1 (\alpha, D) < 1 \) in order for the top ranked institution to have a positive market share.

Observe that sufficient conditions for \( \nu > \hat{\nu}_3 (\alpha, D) = 0 \) are either \( D > \frac{1}{3} \) or \( \alpha > \frac{1}{2} \). For parameter values \( D < \frac{1}{3} \) and \( \alpha < \frac{1}{2} \) the equation \( \hat{\nu}_3 (\alpha, D) = 0 \) shows how decreases in \( D \) must be

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\(^5\) The boundary curve for Region B extends south-westward to the origin. We have suppressed the portion of the curve that lies in Region A.
offset by increases in $\alpha$ if the selective institution to be more selective than its rival in equilibrium.

**Result 1**: For all values of the selectivity parameter $0 < \alpha < 1$ and for $1 > D > \frac{1}{3}$ if the quality of the lower ranked institution $v$ is such that $v < \frac{6(1-D)}{5-2D}$ then a selective market outcome in which $0 < 1 - \hat{\theta}_1^* < \hat{\theta}_1^* - \hat{\theta}_2^*$ and $t_1^* > t_2^*$ is the equilibrium outcome.

Region C in Figure 2 includes the feasible parameter space $(\alpha, D)$ in Result 1. The constraint on the quality of the lower ranked institution $\hat{v}(D) = \frac{6(1-D)}{5-2D}$ is decreasing in $D$. Specifically, $\hat{v}'(D) < 0$, $\hat{v}''(D) < 0$.

**Result 2**: For $1 > \alpha > \frac{1}{2}$ and for $0 < D < \frac{1}{3}$ if the quality of the lower ranked institution $v$ is such that $0 < v < .61$ then a selective market outcome in which $0 < 1 - \hat{\theta}_1^* < \hat{\theta}_1^* - \hat{\theta}_2^*$ and $t_1^* > t_2^*$ is the equilibrium outcome.
For parts of the feasible space not covered by Result 1 or 2, i.e., \( \frac{1}{3} > D > 0 \) and \( 0 < \alpha < \frac{1}{2} \) the following necessary conditions for an equilibrium to be selective do apply.

**Result 3:**

(i) A necessary condition for \( 0 < (1 - \hat{\theta}_1^*) < \hat{\theta}_1^* - \hat{\theta}_2^* \) is \( D \geq \frac{1-\alpha(1+2\alpha)}{3(1+\alpha)} \).

(ii) For \( \frac{\alpha}{1+2\alpha} > D \geq \frac{1-\alpha(1+2\alpha)}{3(1+\alpha)} \), (Region B), a necessary condition for a selective equilibrium is \( 0 < v < \hat{\nu}_2(\alpha, D) = \frac{3(1+\alpha)+D}{2} - \frac{[(1+\alpha)(9\alpha+1-2D)+D^2]^{1/2}}{2} \leq 1 \).

(iii) For \( D \geq \frac{1-\alpha(1+2\alpha)}{3(1+\alpha)} \) and \( D \geq \frac{\alpha}{1+2\alpha} \) (Region C) a necessary condition for a selective equilibrium is \( 0 < v < \hat{\nu}_1(\alpha, D) = \frac{2(1+\alpha)(1-D)}{2-D+\alpha} < 1 \).

The impact of selectivity, as captured by the parameters \( D \) and \( \alpha \), on the market for higher education may be best illustrated by the following example: Suppose that the quality of the credential from the non-selective institution is \( v = .7 \) and that the high quality institution is characterized by the parameters \( D = .35 \) and \( \alpha = .25 \). In this case the outcome is in Region C and it is characterized by the high quality institution enrolling 12.5\% of the student population at a net tuition price of \( t_1^* = .42 \) and the lower ranked institution enrolling 60.8\% of potential enrollees at a fee of \( t_2^* = .19 \). The high quality institution earns only about half the tuition revenue of its non-selective rival. However, given its donations and grant funding, its total revenue is nearly three times higher. Of course as noted earlier, the high quality school is also likely to have a much more costly research-intensive infrastructure to sustain.

This simple example makes clear just how important it is that the high quality institution be selective. Although limiting its enrollment means serving a smaller share of the potential student market, two forces work to offset the tuition loss that this would otherwise imply. First, that increased selectivity results in a greater willingness to pay on the part of those students who do
get in. Second, the ability to earn grant income and charitable and/or alumni donations also rises with a more selective and higher-quality student body. It is also worth noting that, as the foregoing example also shows, that selectivity has the effect here of greatly limiting the market share of the top quality school relative to that of the less-selective university, despite the fact that we have assume a zero marginal cost at each. This is a novel effect as the usual outcome in vertically differentiated markets in which each firm has the same marginal cost is that the high-quality product dominates [Gabszewicz, and Thisse (1979), Shaked and Sutton, (1982)].

Nor are the relative magnitudes in the example above unrealistic. Among private research universities, the four institutions with the highest endowment assets per student received an average of $72,000 of annual endowment income per student, which is significantly higher than the average tuition revenue per student. When grant income is added to endowment receipts, the total non-tuition income at such schools is that much larger relative to tuition income.6

In addition, if we take graduation rates as a rough measure of student success, then the marginal values $\hat{\theta}_1^*, \hat{\theta}_2^*$ are roughly consistent with real world data. In 2004, for instance, only 31 percent of full-time US students who began at an open-admission institution and 45 percent of those at institutions accepting at least 90 percent of their applicants earned their degrees within six years. At the most selective four-year institutions, however, 88 percent of full-time students completed their degrees in six years.7 In our example, the average graduation or success rate is 91 percent at a high quality institution is 91 percent but only 52 percent at a lower quality school.

Now suppose that the value of the corresponding donation and/or grant income of the high

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quality institution increases to $D = .4$, while the quality of a credential from the lower ranked institution and the selectivity parameter remain the same at $v = .7$ and $\alpha = .25$. The high quality school raises its net tuition fee to $t_1^* = .45$, leading it to now enroll only nine percent of the total potential enrollees. A number of those who would have enrolled at the elite school now switch to the lower ranked institution with the result that it now serves 63% of the student population even though it raises its tuition charge to $t_2^* = .195$. Not surprisingly, this increase in $D$ has positive effects for both schools. At the elite institution, total revenue rises by nearly 13 percent. Income at the lower ranked school also rises by a more modest but still significant six percent. However, the fraction of all potential students actually pursuing higher education falls from 73 percent to 72 percent as the weighted average net tuition fee across enrolled student population rises by 24% (from $\bar{t} = .203$ to $\bar{t} = .252$).

In other words, a general rise in asset prices or other positive endowment shock or, alternatively, an increase in grant-earning assets permits the high quality school to become more selective, thereby softening price competition and permitting both institutions to raise tuition prices. Again, these implications are not inconsistent with some of the broad empirical facts of the last 30 years. This period is characterized by an unsteady but overall positive increase in asset prices and real endowment values as Peña (2010) has emphasized.\(^8\) It has also been accompanied by a substantial rise in tuition rates at both highly ranked and lower ranked institutions averaging by some measures as much as three percent per year above the inflation rate on average.

Ehrenberg (2013) documents that the steady rise in tuition has also been accompanied by a much-publicized increase in selectivity at elite schools and declining rates of college participation

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\(^8\) Peña (2010) also argues that the rise in the real value of selective college endowments is a prime source of the rise in tuition rates but his model behind this result is somewhat different. In his model, the rise in $D$ and endowment income implies more and better university facilities that raises students’ willingness to pay.
among the college-age population. As the number of undergraduate students enrolling in degree programs increased from 2000 to 2010 the share of degrees awarded by for profit institutions increased from 4% to 10% enrolling. In contrast the percentage of degrees awarded by public and private nonprofit institutions during this 10-year period declined from 66% to 62% and from 30% to 28%, respectively. In the most recent two years, however, the absolute number of students attending four-year public and non-profit universities has in fact declined. Somewhat paradoxically, though rising endowments and research grants at elite schools can support the scholarship infrastructure essential to a knowledge-based economy, they also can generate a pressure for rising tuition prices and more limited access to higher education across the board.

3. Online Educational Resources, MOOCs: Alternatives to Accredited Degrees

Declining college matriculation rates (especially for young men) and the unrelenting rise in net tuition costs have received increasing media attention in the US. This has led to heightened public scrutiny and even overt political pressure on institutions to increase the general access to higher education in a manner that does not require a large and growing student debt burden. Yet to the extent expanding access means increasing the number admitted it raises two issues for selective schools. First, increasing the size of each year’s cohort directly diminishes the selectivity that makes these institutions highly valued. Second, this increase requires a tuition reduction that raises important financial challenges as well.

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It may therefore be surprising that based on interview data with 83 administrators and faculty from 62 different MOOC participating institutions, Hollands and Tirthali (2014) identify expanding educational access as the number one goal of MOOC creators with the closely-related aim of building the university’s “brand” listed as second. We show here that initiating MOOC sites that give access to alternative or “out of school” ways to acquire valued professional skills are at least a second-best resolution of some of the challenges facing selective schools. In particular, MOOCs can provide a way to increase access without reducing selectivity.

In this respect though, it is important to note that while some MOOCs offer certification for students completing an online class, the academic currency of such credentials remains an open question. Internet-based mode of delivery introduces important challenges to the accreditation process. Hence, these “free” educational resources do not lead to an “accredited” credential or degree. Yet they do provide content and skill-training that could be valued by potential employers or others and are a non-trivial expansion of educational access in that sense.

To understand better the impact of selective schools introducing MOOCs, consider again the model of section 2. Now let the parameter $R$ denote the maximum value of the education attained by the completion of open online courses or MOOCs, which are assumed to available for student enrollment at no charge. Because these classes do not lead to an accredited certificate or degree we assume that this maximum value $R$ that might be realized by any student is less than the maximum value $v$ provided by the lower ranked but accredited school, i.e., $R < v$.

The availability of valuable and free educational services that MOOCs provide does create competitive pressure in the market. Specifically, for lower ranked institutions to have a positive

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12 Microsoft has been and remains an innovator in on-line education that includes MCSE certification. Somewhat similarly, the Mozilla Foundation offers badges of skill achievement or competency. Again though, there is considerable doubt about the ability of these certificates or badges to receive academic accreditation.
market share it must be the case that the marginal student $\hat{\theta}_1$ at a high quality institution prefers a degree from either attending an accredited institution than pursuing a free online non-accredited alternative; that is, given net tuition prices $t_1, t_2$, we must have: $\hat{\theta}_1 - \alpha \tilde{x}_1 - t_1 = \hat{\theta}_1 v - t_2 > \hat{\theta}_1 R$.

The marginal student $\hat{\theta}_2$ at the lower ranked institution is indifferent between the value of the opportunities presented by online educational resources and the value of the lower ranked degree as defined by the condition: $\hat{\theta}_2 v - t_2 = \hat{\theta}_2 R$.

Tuition competition for students at the accredited institutions leads to the following best response functions:

$$t_1 = \frac{(1 + D \cdot v + t_2)}{2}$$

(13)

$$t_2 = \frac{(a + t_1)(v R + t_3(1 + a \cdot v))}{2(1 + R + \cdot v)}$$

It is easy to see that the availability of acquiring skills that yield a maximum value $R$ at no charge shifts down and flattens the best response function of the lower ranked institution. This of course spills over to tougher price competition overall leading to lower equilibrium tuition prices at both accredited institutions:

$$t_1 = \frac{2[(D + 1 \cdot v)(1 + R) + (v R)]}{4(1 + \cdot R + \cdot R)_{3R} v}$$

(14)

$$t_2 = (v R) \frac{2 + 1 + D \cdot v}{4(1 + \cdot R)_{3R} v}$$

Tuition prices at both institutions are, as expected, decreasing in the value of the free educational resources as measured by $R$, i.e.: $\frac{\partial t_1^*}{\partial R} < 0, \frac{\partial t_2^*}{\partial R} < 0$. Likewise, this implies a change in the marginal students as follows:
\[ q_1 = \frac{(2 + 1 + D - v)(2 + 2 R - v)}{(1 + v)(4(1 + ) 3R - v)} \]

\[ q_2 = \frac{2 + 1 + D - v}{(4(1 + ) 3R - v)} \]

The \( \theta \) value of the marginal student enrolling at each institution increases, implying that the market shares of both types of institution decline, as \( \frac{\partial \theta R}{\partial R} > 0 \) and \( \frac{\partial \theta I}{\partial R} > 0 \). However, because of the availability of the free alternative mode of credentialing it is now the case that the entire population of students seeking some form higher education is served.

The vertical nature of the quality in higher education however implies that the impact of the free educational resources or MOOCs as an alternative credential is markedly different for the two accredited institutions. To see this, consider the example discussed above in which the higher education market is characterized by the following parameter values: \( v = .7, \ D = .35 \) and \( \alpha = .25 \).

As noted above, the equilibrium in the absence of any free MOOC alternative is characterized by tuition charges: \( t_1^* = .42 \) and \( t_2^* = .19 \), and with the elite institution enrolling 12.5% of the student population and the non-elite institution enrolling 60.8% of all potential students. What happens if we now introduce into this market a new MOOC rival offering educational services with a maximum value of \( R = 0.2 \), and offering them for a zero price?

The entry of the free MOOC alters the market equilibrium in a variety of ways. To begin with, the zero-price MOOC introduces some tougher price competition. As a result, the equilibrium tuition fees now fall to \( t_1^* = .40 \) and \( t_2^* = .15 \), implying declines of 3.8 percent and 17.1 percent for the two schools, respectively. The vertical or ranked hierarchy of the three educational services means that the pricing pressure introduced by the MOOC bears much more intensely on its nearest rival, the lower ranked school.
However, the greater proportionate fall in the non-selective school’s tuition price means that it now becomes somewhat attractive to formerly marginal students at the selective school. As a result, the selective institution sees its share of the potential student market fall from 12.5 percent to just under 10 percent. Yet its non-selective rival does not gain students overall because the share of students it gains from the selective school is more than offset by the larger number of students that it loses to the free MOOC alternative. In equilibrium, the non-selective school now serves 59 percent of the eligible student population. Note too that while the selective school loses some market share, these loses are concentrated among its lowest $\theta$ students. Consequently, the average quality of its students rises with the result that its grant and endowment income productivity (per student) also rises thereby further softening the competitive blow introduced by the MOOC.

The overall impact of the MOOC’s entry is thus very different for the two accredited institutions. Whereas the non-selective school sees an overall revenue decline of 19 percent, the selective school’s revenue falls by under one percent. Moreover, this more modest impact would be even smaller if the selective institution were less tuition dependent. For example, if in the foregoing example we had instead assumed a value of $D = .4$, the entry of the MOOC would reduce its total equilibrium revenue by only half of one percent.

In light of the above analysis, it is perhaps not surprising that it is elite institutions that are most heavily engaged in generating MOOC classes. Thus, EdX is a joint effort of MIT and Harvard and its charter members include Berkeley, Cal Tech, Columbia, Cornell, Dartmouth, McGill, Rice, and the University of Chicago among others. Likewise, Coursera started in 2012 as a joint effort among Stanford University, Princeton, the University of Michigan, and the University of Pennsylvania.

Offering MOOCs addresses each of the two major challenges that the selective institution faces in expanding educational access. It permits the selective school to leverage its brand without
diluting it. That is, it permits the selective school to offer expanded access to educational services without reducing the selectivity of the school itself. Yet because the negative revenue impact of the competition that the MOOC introduces falls so heavily on the non-selective school, the reduction in the selective school’s revenue is relatively small.

Weissman (2012), among others, has queried the business model that will make MOOCs sustainable. The major possibilities at this point seem to be: 1) certification in which students pay for a badge or certificate; 2) employee recruitment in which companies pay for access to student performance records; and 3) applicant screening in which employers and/or universities pay for access to records as a means of screening applicants. Typically, however, these activities require partnership with a private firm, e.g., Pearson VUE, to administer the MOOC and authenticate student performances. Such intermediaries though typically take a large share of any profit so that the net revenue to the school can be modest. Yet as shown above, the net revenue may not need to be very large in order for the selective school to break even.

Suppose for example that the selective school in our model introduces a MOOC that charges a positive but low administrative fee, as Stanford has done with Coursera.\(^\text{13}\) This has both a direct and an indirect effect. It directly raises revenue from those students who enroll in the MOOC. Indirectly, however, it works to reduces price competition between the MOOC and the non-selective school permitting the latter to raise its tuition fee, and this again spills over to a higher optimal fee at the selective institution itself. There is as well a further indirect effect. As the selective school raises its tuition, it again loses its least well-prepared marginal students so that its average student quality rises, which leads to an increase in grant and donation income. In our model, a fee of \( t_3 = 0.016 \) for the MOOC results in fees of \( t_1 = 0.402 \) and \( t_2 = 0.16 \), respectively, and

\(^{13}\text{Because the MOOC does not lead to an accredited credential the fee is different from a tuition charge.}\)
this is sufficient to restore the selective school’s pre-MOOC income. In other words, in this example, a MOOC fee of about one tenth the non-selective school’s fee and less than one twenty-fifth of the elite tuition price is enough for the selective school to break even by offering a MOOC.\(^\text{14}\)

Thus, if the elite per course fee were $4,000 the break-even MOOC fee would be under $160—surprisingly close to the $100 that Coursera charges for identity-verified completed courses.

Beyond a modest fee for the MOOC, the elite school’s effort to expand educational access may also attract donations and grants. For example, the Gates Foundation donated $1 million to MIT in support of its effort (joint with Harvard) to launch the EdX online learning program. Relatedly, the data generated by the EdX courses are likely to be the basis of subsequent grant-funded research.

Within our model, it takes only a relatively small rise in \(D\) to offset the selective school’s revenue loss that a MOOC introduces. This is only partly due to the fact that an increase in \(D\) directly raises endowment and grant income. It is also due to the fact that as donations and grants become more important, tuition price competition is again softened..

In short, the high quality or research intensive schools are in a better position to offer MOOCs. These on-line classes do not compete directly with those schools. As a result, even a modest fee for such on-line classes or relatively small increases grant and donation income may make the MOOC affordable.

4. Summary and Conclusion

American higher education includes selective institutions that both create and disseminate knowledge and less selective institutions that primarily focus on the latter in their mission. The elite knowledge-creating schools are selective in their student enrollment, limiting access to those students who will benefit and add value to their knowledge creation mission. To cover the cost of

\(^\text{14}\) Again we consider parameter values satisfying conditions where both institutions have positive market share.
creating knowledge and educating their students in a research based curricula elite schools depend upon donations and grant income. In turn this external funding depends upon success, talent and value-added in the education of students at elite institutions.

We have presented a very simple, vertically differentiated model of higher education that captures these factors in a parsimonious manner. Our model sheds light on some of the competitive dynamics of the higher education market. In particular, it makes clear the softening effect of grant and endowment revenue streams on direct tuition-price competition. The model also shows how increasing weight on selectivity as characterized by a negative enrollment externality at elite schools similarly reduces the intensity of competition for students.

Perhaps most notably the model allows us to understand the impact of recent innovations in online educational resources, e.g. MOOCs that have introduced large scale economies into higher education production. It is clear that the disruptive effects of new digital classrooms are likely to be most severe for their nearest neighbor in the vertical education chain, namely, the non-selective schools. In this same connection, the model also provides insight as to why it has been predominantly the elite institutions that have fostered the development of MOOCs. Because these innovations primarily eat into the income of the less selective schools, they can serve as a tool to “squeeze” this competition. Moreover, a relatively small MOOC fee is all that an elite institution requires to recoup the revenue loss. This is especially true if creating a MOOC class leads to either more grant or more foundation income for the elite institutions. To our knowledge, this paper is the first to explore innovations in education production in a theoretical model of competition in higher education.
5. References


