# Price Discrimination in Higher Education

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This paper uses a structural model to explore third degree price discrimination in post-secondary education costs, both in a demand and supply context. Theoretically, an equilibrium exists such that students will be stratified by ability and income across a spectrum of schools differentiated by tuition price and prestige. Students with higher price elasticities-caused by lower incomes and/or higher abilities-will receive education at lower costs whereas students with lower price elasticities-caused by higher incomes and/or lower abilities-will receive education at higher costs. The proposed model provides a framework for understanding how students match with universities. A brief discussion of possible data to be used for empirical research in the future is provided and additional research and preliminary considerations are reported in the appendices.

## 1. Introduction

Financial aid and scholarships have long been used by universities and colleges as an accepted method to price discriminate their student customers. By utilizing these financial offerings, a university can reduce the net price for certain groups of student recipients, e.g. low-income and/or high-performing students, such that enrollment objectives and university revenue are maximized. For some universities in highly competitive tranches of the market, the selection of these offerings becomes a key component in attracting students where education alone can no further be differentiated.[1] Likewise, where a university's education and prestige earn them a place in a less-crowded, luxury tranche of the market, monopolistically competitive forces allow for increases in tuition costs without decreasing enrollment.

In order to effectively use these tools, universities must have adequate and accurate information regarding their student applicants. Universities mitigate asymmetrical information obstacles through rigorous application processes. Using the Free Application for Federal Student Aid (FAFSA)[2], writing samples, test results, resumes, cover letters, interviews and other information gathering techniques, universities obtain pertinent student details such as college placement scores, high school grade point average, family household income, etc.[3] The paper incorporates a simple bargaining framework where this information is then used by the university and student to agree on an appropriate tuition price. For purposes of the following proposed model, it is assumed that universities and student applicants largely share symmetrical information.

[1] Each university is differentiated by quality, major options, resources provided, location, sports teams, etc.

[2] A growing number of universities also require the College Scholarship Service profile (CSS) which is offered by the College Board. It is designed supplement the FAFSA in order to give a closer look into household finances and expenses of a student and family. It is much more detailed than the FAFSA.

[3] Universities have access to financial aid information which reveals some heterogeneity in budgets, though perhaps not in terms of preferences.

Tuition for higher education is well suited for the theory of price discrimination for the following reasons:

- Students cannot resell their admission and enrollment on a secondary market, thereby eliminating arbitrage factors.
- Differences in price elasticities among students result in different optimal prices when price discriminating.

Ideally, this model would capture different aspects of price variation and price discrimination through product differentiation. Universities are considered highly differentiated, where differentiating characteristics include location. The model presented in this paper will offer a structural approach for estimating price discrimination by higher education institutions.[4] Section 2 presents the theoretical model from both the supply side and the demand side. Section 3 provides an overview of possible data sources as well as a discussion on the ideal data set. Finally, section 4 contains the concluding remarks. Note that additional details and insights are included in the appendices in order to streamline the paper's primary content.

## 2. Theoretical Model

I present a theoretical framework that models the salient characteristics observed in the market for higher education with some significant simplifications. The model is meant to capture the demand and supply factors that affect the market for college.[5]

### 2.1. Demand

The model incorporates two key elements of student heterogeneity: ability and household income. These two elements are accompanied by the following basic assumptions. A student with higher ability relative to her contemporaneous applicants is assumed to (1) have higher expected academic achievement and (2) increase the academic achievement of her student peers. Additionally, students or student households with higher income levels are assumed to have higher levels of demand for academic achievement (Lawson & Zerkle, 2006).

For purposes of this model, a high ability student applicant is defined as a normal good for higher education institutions while a students' income has little to no bearing on her classification. In addition, it is assumed that a student with an income or household income higher relative to her contemporaneous peers will cross subsidize the schooling of relatively low-income students. Thus, schools can attract high-ability, low-income students by offering lower tuition cost via scholarships, fellowships, and financial aid while "overcharging" higher income, low ability students.

There can be two sources for differences in price elasticities: (1) observable academic quality of student and (2) ability to pay - financial need. In general it is assumed that better students will have a higher price elasticity because they have more college options and may be more able to select based on price. Similarly, poorer students are also assumed to be more price elastic because tuition can be a bigger burden. Operating on these assumptions, we would expect to see lower tuition for high achieving students and poorer students (Epple & Romano, 1998).

[4] Other aspects to consider if we extend this model to more than one university: (1) location (in-state tuition versus out-of-state, close to home to off-set housing costs), (2) ranking and perceived value (prestige effect), (3) application process (common app or not), (4) elements of 2nd degree price discrimination such as honors programs, etc.

[5] A simplified process is mapped out in Appendix B.

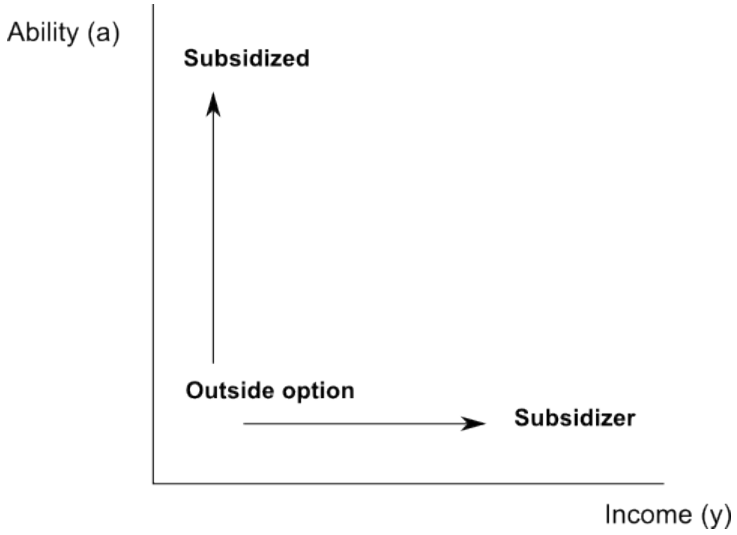


Figure 2.1: Student Heterogeneity

I define g(y,a) as the joint marginal distribution of ability and income in the population with positive continuous support, $S = (0, y] \times (0, a]$.

In the model, the university characteristics include the location, private/public, and total enrollment. The location of the university may interact with the location of the student's hometown and the student's other preferences. Students may also have difference preferences for private versus public schools and the size of the school. Therefore, in addition to the student's ability, the student's specific characteristics and preferences are included in the function for utility.[6] Moreover, the student's utility will depend on the quality of peers (Rothschild 1995), which can be proxied by the averaged ability at the university (m).

Next, I consider the cost of education for the student. Though the model simplifies income to a general amount, the amount can be garnered from the income of the parents or the household as well as income the student's ability to borrow money. Essentially, the student's economic costs are defined as the sum of the tuition related monetary expenditures as well as prestige loss.

The level of utility that a student derives from attending a particular school is a function of the school characteristics (X), the student's ability (a) and the student's other characteristics (B), the student's specific preference for the quality of peers at the university (h(m,a)), and the tuition (t(y,a)) amount minus income (y).

Finally, I assume an implicit bargaining process between the university and the student based on the respective optimization problems in order to arrive at t(y,a). Note that student and university bargaining power will depend on the student's elasticities and both parties' perceived bargaining power. An overview of a simple university/student bargaining model is included in Appendix D.

Equation 2.1 is a general form to the value function of attending a certain university.

$$U\Big(y - t(y,a), h(m,a), X, B\Big) \tag{2.1}$$

Assuming the student complies with the individual rationality constraints (IR), the student will opt to attend the university that gives the student with highest utility, $U_i > U_j$.

[6] This vector of variables would include gender, race and hometown and should capture effects from programs and policies like affirmative action.

### 2.2. SUPPLY

The following assumptions are made to describe the higher education market: (1) schools may price discriminate students by income who are not on the margin between going to another school and will charge the highest possible tuition before the student reaches this margin; (2) no two schools are perfect substitutes, a limitation which comports with reality; and, finally, (3) new universities may not enter the market, however, creating a dynamic process may be a natural extension to this model.

Not all universities share the same maximization goals. In order to adequately compare diverse universities, the university's not-for-profit status and economic efficient must be taken into account. If the university's primary objective is not to make a profit, then performance cannot be measured solely by a profit criterion. As a result, prestige is affected by the quality of product produced. Therefore, both quantity and quality are elements of the universities maximand (Newhouse, 1969).

Theoretically, the price of attendance will effect both the quality and quantity of product. Therefore, the university will consider tuition in its optimization problem ($t(y,a)$), which again will be the result of an implicit bargaining process. Other factors that will affect the university's optimization problem will be a function of the density of the population considering higher education ($g(y,a)$) as well as the probability that a student of a particular income and ability will accept an offer from the university ($f(y,a)$). Finally, the cost associated with operating a university depends on fixed costs as well as the number of students enrolled, where inputs vary with size. $C(N)$ is the cost function of the university.

The university maximize their objective function:

$$\pi = \int\int_S t(y,a)g(y,a)f(y,a)dyda$$

subject to:

$$C(N) = V(N) + F$$

Theoretically, a university would accept trade-offs between ability and tuition revenue. Depending on the university, the shape of the isoquants will be different. Appendix C provides a brief discussion of the possible variation of university preferences based on interviews with industry experts.

## 3. POSSIBLE DATA SOURCES

In order to estimate the structural parameters of the theoretical model presented both demand and supply shifter should be captured in the data. Throughout the exploration process, several data sources were considered. This section discusses the merits of each data set. Note, using multiple sources of data, or possibly merging data sets may be necessary to capture both supply and demand in a robust way.

### 3.1. THE NATIONAL CENTER FOR EDUCATION STATISTICS (NCES)

NCES collects, analyzes and reports statistics and data related to education in the United States and other nations. Of the numerous surveys developed by NCES, the following survey seems most viable for this research.

**Education Longitudinal Study of 2002 (ELS 2002)**:
This survey is a nationally representative, longitudinal study of high school sophomores in 2002 and high school seniors in 2004. The students are followed throughout high school and college years. The

unique feature of this survey is that it includes surveys of the student, the student's parents, math and English teachers and school administrators. Additionally, along with complete high school transcripts, the data set also includes student assessments in math from 10th and 12th grade as well as English assessments from 10th grade.[7]

What makes this data set relevant to this model are the questions that would proxy for the student's preferences for colleges as well as what college. Previous versions of the NLS questionnaire (1972) also include which schools the student, as a senior, was accepted to (up to 3 colleges/universities) as well as which school the student accepted offers from.

### 3.2. University Specific Data

Universities regularly maintain admissions results and student educational records. The following discussion provides an overview of each universities characteristics and known available data.[8]

**University of North Carolina (UNC)**
UNC is ranked among the highest universities in the US. There are just under 30,000 students. As a result of its high ranking, UNC generally only accepts high ability students. In-state tuition is over $8,000 and out-of-state tuition is just over $30,000. UNC does not match the model precisely, but if data is available for NC State and Duke, the model could be modified to consider students' decisions to attend each respective school based on perceived ranking and relative price.

UNC also conducts an additional survey post-acceptance called Admitted Student questionnaire (ASQ). This survey is distributed to students who both accepted and rejected UNC's admissions offers. This survey may provide some insight on other student characteristics and preferences that affect university matching.

**Arizona State University (ASU)**
ASU is the largest university in the United States with 72,254 students. ASU admits approximately 87% of all applicants. The base in-state tuition is over $10,000 and nearly $24,000 for out-of-state tuition. This university would be particularly interesting for both research on price discrimination but also bargaining, because the institution closely competes with The University of Arizona and Northern Arizona University for both revenue and high ability students.

Based on interviews with industry experts, each of the three public universities in Arizona carefully maps strategies in order to capture the best combination of high ability students as well as revenue through tuition and research. This university would be generally consistent the general isoquant considerations discussed in Appendix C.

### 3.3. Ideal Data Set

Given the inputs specified in the structural model, the ideal data set would include a comprehensive survey that incorporates a representative sampling of universities and students nationwide. The data set would include elements to identify both supply and demand. Data regarding the student would include demographics, high school transcripts, college acceptances, tuition offerings and final university choice. From the supply side, the data would include the number of students applications, the number of acceptances and the corresponding tuition offerings. Barring any regulations by FERPA,

[7] Note that due to the detailed information, this data set is highly restricted.
[8] Note that these data are also highly restricted particularly due to The Family Educational Rights and Privacy Act (FERPA), the federal law that protects the privacy of student education records.

this data set would allow for the analysis of matching between students and universities based on student and university characteristics, tuition and other sources of heterogeneity.

## 4. Concluding Remarks

The cost of higher education is receiving more and more attention as tuition rates rise and expected future income remains more or less constant. This research aims to develop a robust model that can provide structural connections that link student and university preferences, education (the production of human capital), university costs, the process of financing college tuition and the overall structure of higher education. This research would provide a useful foundation for analyzing the effects of policies on the production of human capital via higher education. Ideally, a model like this would be able to provide testable predictions for supporting or vetoing particular policies.

# A.
# SOURCES

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# B.
# Process Overview

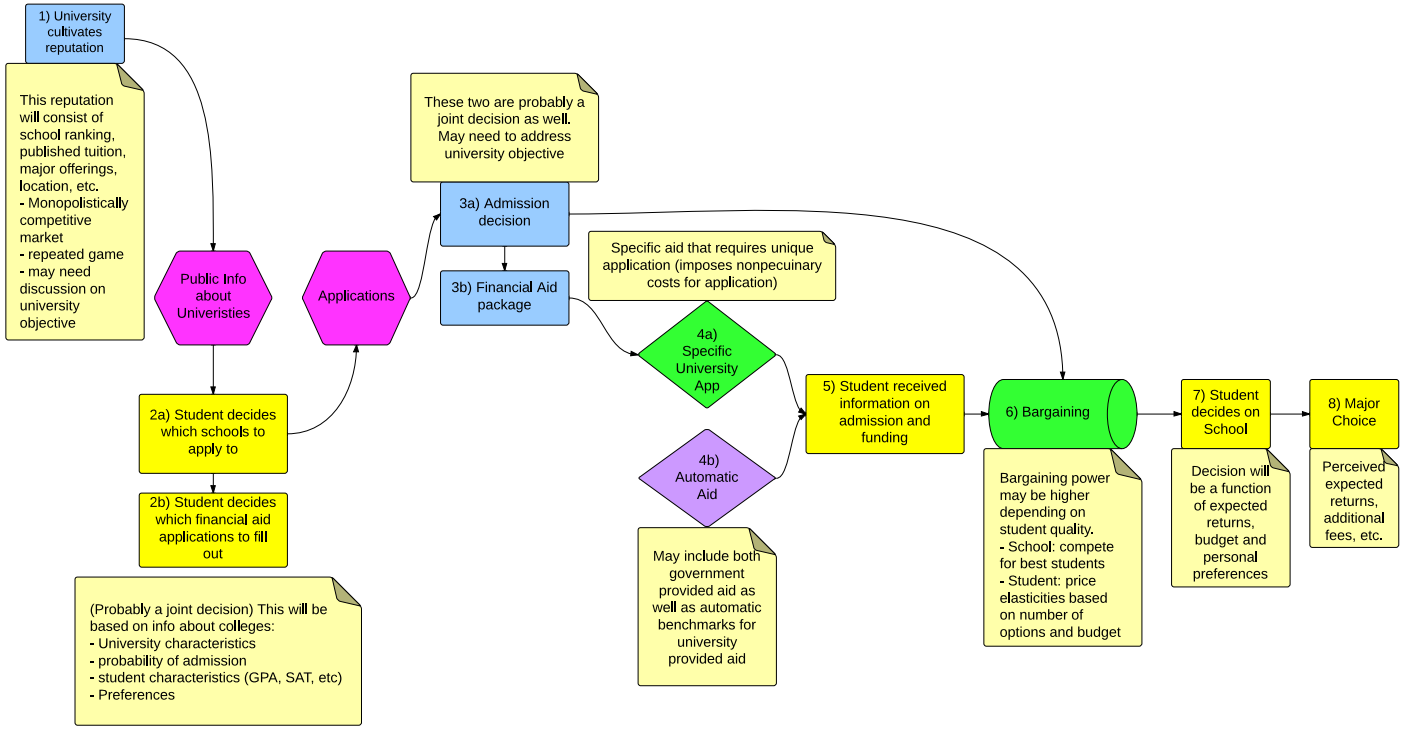


Figure B.1: Higher Education Matching Process

# C.
## University Isoquants

We can imagine a spectrum of different universities and colleges with different objectives that vary favoring revenue versus favoring high ability students.

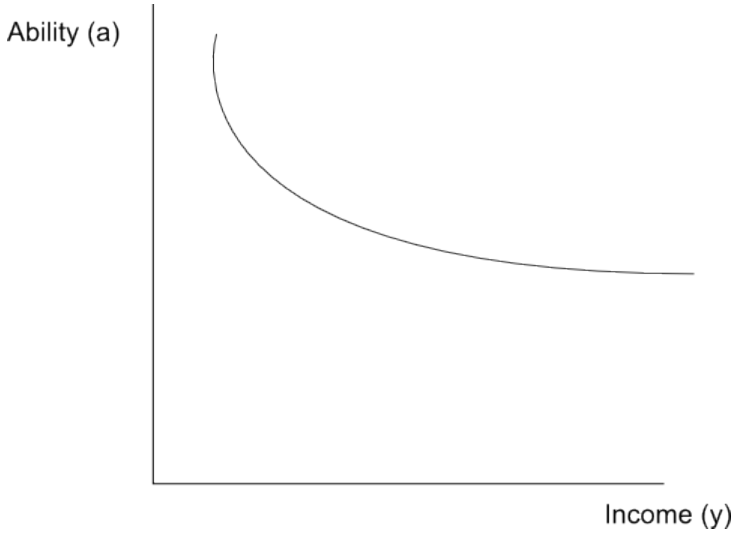


Figure C.1: High Ability Focused University Isoquants

Universities with larger endowments or prestigious reputations that are able to consistently attract and select high ability student may be more likely to choose a higher ability student instead of focusing on students who will bring in more revenue through tuition. The universities on this side of the spectrum intrinsically have more bargaining power so they do not have to compromise high ability for more tuition.

On the other extreme, for-profit universities are becoming more prolific by organizations like the

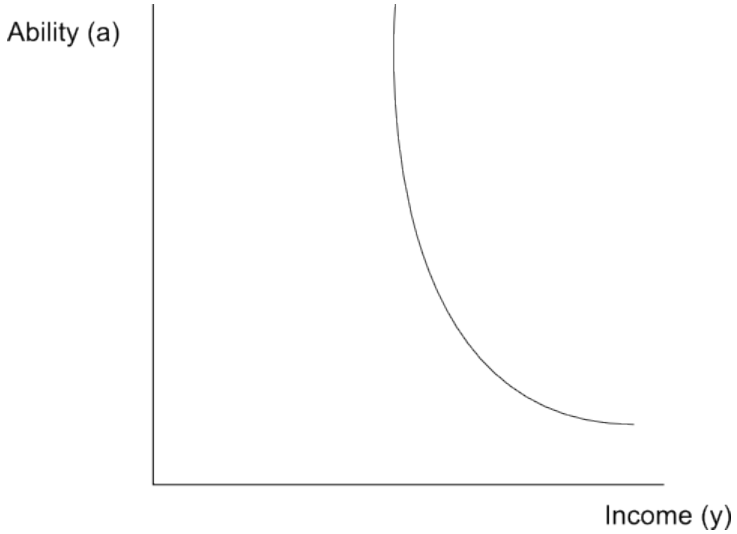


Figure C.2: Revenue Focused University Isoquants

Apollo Group, which manage The University of Phoenix among other for-profit education programs. Generally, these universities charge a premium for convenient online courses, and do not try to attract students with higher ability peers or prestige. [9]

[9] Indicative of these revenue focused objectives, these degree programs have received significant press for predatory student

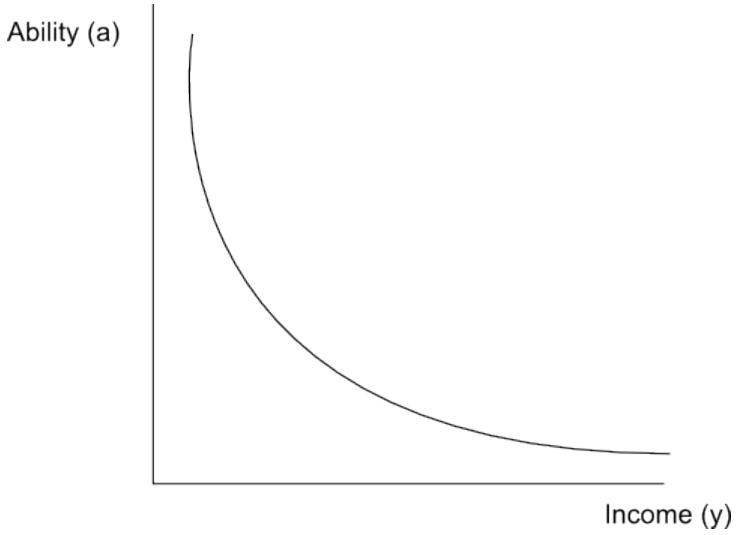


Figure C.3: Standard University Isoquants

The general model described in this paper considers a school somewhere in the middle of this spectrum. By attracting students who are willing to pay full tuition, most schools are able to subsidize the other students with higher ability or more financial need. Moreover, these universities do not have an inordinate amount of bargaining power either, which creates a wider range of tuition via both merit based scholarships as well as financial aid.

targeting (Greenwald 2013).

# D.
# TUITION BARGAINING

The process of tuition bargaining is not explicitly modeled here, though there is evidence that bargaining does occur at come institutions (Lieber, 2014). Industry professionals at 3 different universities (ASU, UNC, and the University of Arizona) have confirmed that renegotiation of financial need is the most common form of tuition adjustment.

My treatment of the bargaining process from the economic game theory perspective is extremely simplified for the sake of this model.

- The economic actors are the student and the university or universities competing for the student.
- The student's decision can be to accept the offer of admissions and tuition price or to reject for another option (no degree or a different university). The university can choose a spectrum of different tuition prices in order to compete for the student's attendance.
- The student's payoff will be discounted future income less tuition. The university gains tuition minus the cost of having that student attend.

Using simple game theory, I will provide a framework for understanding why and when universities and students may bargain and how each economic actor's decision affects the overall payoff. Moreover, I discuss how surplus is shared between the two parties.

## D.1. SIMPLEST GAME - 1 STUDENT AND 1 UNIVERSITY

The simplest game would be 1 student and 1 university, where the outside option is normalized to zero.

The student's economic surplus would be the discounted lifetime expected earnings from having a degree from the university ($E\left[w_{degree}\right]$) less the discounted expected earnings from not having a degree ($E\left[w_{nodegree}\right]$) less tuition ($t(y,a)$).

$$\text{Student Surplus} = E\left[w_{degree}\right] - E\left[w_{nodegree}\right] - t(y,a)$$

The university surplus would be tuition less university costs associated with that student attending (for simplicity of notation, C).

$$\text{University Surplus} = t(y,a) - C$$

Depending on bargaining power, the university and the student will split the total surplus:

$$\text{Combined Surplus} = E\left[w_{degree}\right] - E\left[w_{nodegree}\right] - C$$

## D.2. SIMPLE GAME - 1 STUDENT AND 2 UNIVERSITIES

To move toward a more applicable example, suppose there are two universities: A and B. We redefine the "outside option" in each scenario when calculating surplus.

The student surplus from attending A is:

$$E\left[w^A\right] - E\left[w^B\right] - t^A(y,a)$$

Similarly, the student surplus from attending B is:

$$E\left[w^B\right] - E\left[w^A\right] - t^B(y,a)$$

Given this framework we can redefine university surplus as follows:

$$\text{Surplus if student attends A: } t^A(y,a) - C^A$$

$$\text{Surplus if student attends B: } t^B(y,a) - C^B$$

With two universities bidding for one student there are 4 possible scenarios: (1) each university offers identical expected earnings and share identical costs, (2) one university offers higher earnings but both share identical costs, (3) each university offers identical earnings but have different costs and finally (4) universities are heterogeneous in expected earnings and costs. In each of these cases, the range of surplus that can be split will depend on the bargaining power of each party. If the student is of higher ability or a lower income (with high price elasticities) then she will be able to extract more surplus.

**Case 1: identical earnings and costs**
This case will resemble a Bertrand game where two firms produce identical goods and the consumer will buy from the producer who charges the lowest price. Therefore A and B will bid down tuition to the university's marginal cost and the student will extract all of the surplus.

**Case 2: different earnings and identical costs**
Without loss of generality, suppose expected earnings from A are greater than expected earnings from B. Then in order for A to "win" the student A would be able to charge a tuition:

$$t(y,a) \in \left[C, E\left[w^A\right] - E\left[w^B\right] + C\right]$$

Note, that here we assume that $C^A = C^B$. The student and A would then share the combined surplus based each party's bargaining power and the ultimate tuition price offered to the student.

**Case 3: identical earnings and different costs**
Without loss of generality, suppose costs incurred by A are less than the costs incurred by B. Then in order for A to "win" the student A would be able to charge a tuition:

$$t(y,a) \in \left[C^A, C^B\right]$$

The student and A would then share the combined surplus based each party's bargaining power and the ultimate tuition price offered to the student.

**Case 4: different earnings and different costs**
Suppose:

$$E\left[w^A\right] - C^A \geq E\left[w^B\right] - C^B$$

Then A would be able to "win" the student and charge a tuition price:

$$t(y,a) \in \left[C^A, E\left[w^A\right] - E\left[w^B\right] + C^B\right]$$

The student and A would then share the combined surplus based each parties bargaining power and the ultimate tuition price offered to the student.

The bargaining game can be extrapolated further with several universities competing for one student. This additional complexity could incorporate additional forms of heterogeneity and price discrimination through spatial discrimination (Hamilton 1989) and search costs (Marshall 2013). This is relevant given that since the year 2000 the number of universities in the United States alone has growth nearly 10 percent. This intrinsically increases search costs via research and application costs (U.S. Department of Education (2013)).