A Study of Different Tuition Pricing Structures Used by Universities in the United States

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May 4, 2011

HONORS THESIS

Abstract

Universities in the United States charge tuition in different ways. Some charge tuition per credit hour, others charge a lump sum fee for unlimited classes, and the rest use a combination of the two. I explore these pricing structures in a practical framework. I also introduce and develop two theoretical models that help explain the different pricing schemes. My primary goals are to determine the optimal pricing structure for a university that wants to maximize its producer surplus and investigate if schools are using their optimal pricing structure. I do this by first making several assumptions about the aggregate student demand curve for education and the market power of universities. I then examine the pricing structures of the top two hundred universities in America as ranked by the US News & World Report rankings. I find that schools do tend to use the pricing structure theorized as optimal.

I wish to thank Dr. Jack Barron for his guidance, suggestions, and support. I would also like to thank the other students in the honors thesis class at Purdue University for their helpful comments. All remaining errors are my own.
Introduction

The idea for this paper came about when I discovered that different schools charged tuition in different ways. When I started school I was only aware of the pricing structure in which a school either charged a per credit hour rate that allowed students to take one or two classes or charged a single lump sum that gave students full-term status and the ability to take as many classes as desired. Apparently, even looking at just the top two hundred schools as ranked by the US News & World Report rankings, there are several very different pricing structures. This paper will explore these different structures.

First, let me introduce some common terminology. Different schools have different terms that often refer to the same thing. In this paper schools can charge either a lump sum, which is a one-time payment irrelevant to number of classes, or a flat rate, also called a per credit hour rate, that is multiplied by a number of credit hours to determine the total cost. The terms price, student price, payment, and student payment will be interchangeable in this paper and will refer to the total financial amount owed by the student to the university, unless otherwise noted. The word university will also be interchangeable with school or college. This paper deals only with undergraduate educations provided at PhD granting institutions. The pricing rules for graduate students follow their own sets of rules and norms and will not be discussed here.

Note that this paper will be ignoring costs associated with room, board, travel, and anything else not expressly associated with education. It should be that this only includes tuition, but many schools have split their fees into tuition fees, ID fees, technology fees, and many others. It is impossible to sign up for classes without paying the student ID card fee, the information technology fee, and varying other fees depending on the school. It is, however, possible to sign up for classes without paying the estimated students personal costs, so these will be ignored. In general, if a payment is explicitly required for taking classes then it’s in and if it’s not it will be ignored.

Schools have many different ways of charging for both part-time and full-time education. They charge in lump sums, flat rates, and many different combinations of the two. The purpose of this paper will be to explore these different structures, examine which structures
are optimal in terms of producer surplus (where the schools are the producers), and point out some correlations between the pricing structure a school uses and the characteristics of the school and its students. These characteristics include the rank of the school, the percentage of students enrolled part time, the academic achievement in high school of the students, the wealth of the students and their families, and the university’s six-year graduation rate.

The dataset I use contains the top two hundred American universities as ranked by the US News & World Report ranking. By refining our dataset to these schools we get a mix of schools that charge per credit hour and per lump sum. Some schools do not publish all of their statistics and as such, we won’t have a sample of size two hundred for all of our correlation tests.

Before continuing I think it would be decent to mention that all students who attend or even try to attend college are by their very nature hard-working and intelligent people. However, the subset of all people who attend college will be broken down further and analyzed in this paper. By the nature of rankings and comparisons, some schools and some students are at the bottom end. I want to state clearly it is not my goal or intention to insult any schools or students.

This paper is organized into seven sections. The second section will introduce, explain, and rationalize the assumptions I’ll be working under. The third section will present other relevant literature. The fourth section will introduce the model for aggregate student demand. The fifth will describe and analyze the different tuition pricing structures. The sixth section will present in a loose and mild manner some actual data including the number of schools using each pricing structure and some relationships between the structure the school uses and some characteristics both of the school itself and of its students. In the seventh and final section I will provide some closing remarks.
2  Working Assumptions

Given the theoretical nature of the first half of this paper, it is useful to clarify some assumptions that will be made. These assumptions will indeed be simplifying, but will serve to clarify the discussion of different pricing structures. Assumptions other than the ones listed below will be pointed out throughout the paper as they arise.

2.1  Schools as Price Makers

The first assumption of this paper is that schools are price makers as opposed to price takers. The primary reason we can make this claim is because of the tremendous barriers to entry for new universities. Creating a highly ranked university from scratch is nearly impossible. It is also possible to view each university as a monopoly on that school’s degree and location. While students are becoming more and more willing to travel around the country for their education, there are still significant barriers preventing higher education from being a perfectly competitive market. Students on the West Coast who want a top education have just a few places to go. As such, these schools are members of an oligopoly and can be price makers rather than price takers as suggested by the recent, massive tuition hikes implemented by the California state school system which have not yet seemed to negatively impact either the number of students enrolled or the quality of those enrolled.

A secondary reason that we can treat schools as price makers is the complete impossibility of re-sale. A student who earns a degree cannot simply sell his qualification to somebody else and give that person the degree. This means that if a person wants a degree, there is no other place for him to get it except from a university. This gives the universities power and makes them price makers.

2.2  Zero Marginal Cost

Another major assumption this paper will make is that at the top two hundred universities there is a zero marginal cost to add another credit hour. The infrastructure at these schools is set up in such a way that there is room to add more classes. There are enough professors and graduate students that adding more sections should also not be a problem. After so
many classes are added, new buildings will need to be built and new professors hired, but in the short run there is a zero marginal cost to supplying more classes.

2.3 Schools Use Optimal Pricing Structures

This is the assumption most likely untrue. Some schools I'm confident do charge an optimal, in this case most profitable, rate, but many schools probably have other factors to consider. Public schools often have their rates and policies significantly impacted by state governments who have motives other than profit. They care about local students being both admitted and not having to pay a lot. Determining whether this behavior by state politicians is because of their altruism or desire to be re-elected is outside the realm of this paper. Also outside this paper’s borders are whether or not schools charge the absolute optimal rate. This paper will instead serve to introduce and explain some current pricing structures, under the assumption that schools use their optimal structure.

2.4 Financial Aid

All schools provide some amount of financial to some subset of students. In this paper, financial aid will be largely ignored.

2.5 Non-Degree Seeking Students

I will also group all students together, regardless of whether or not they are degree seeking. Some students are only interested in taking a few classes to learn a technical skill or language, but for the most part students taking classes at prestigious universities are doing so to earn degrees. Non-degree seeking students will not be ignored but will simply be considered degree seeking to simplify the student demand for education model.

2.6 Students Take One or Five Classes

This is another simplifying assumption. At almost all universities, students can sign up for any discrete number of classes. However, if we say that students can only take one class, and we call them part-time, or five classes, and we call them full-time. Our first model
becomes much more straight-forward to work with. Our second model will not use this assumption.

3 Literature Review

There has been a growing interest, both in academia and the media, about the price of higher education. Current literature regarding the price of today’s college education deals with such topics as student elasticity of demand for education, the rising cost of education, the value of a degree, and distance learning. However, there has been very little published that explores the different pricing structures used by schools. This paper will be using adapted versions of two-part tariff models and concepts common in the markets for electricity and other utilities and applying them to the price of a college education. It will also reference articles about the price of an education.

3.1 Oi (1971)

In his 1971 paper *A Disneyland Dilemma: Two-Part Tariffs for a Mickey Mouse Monopoly*, Walter Oi develops a model that explains how Disneyland can optimize its revenue by employing a form of second degree price discrimination, namely a two-part tariff, to extract as much consumer surplus from its customers as is legal. I will not use the exact model that Oi used in his paper, but many of the ideas and concepts found here are derived from Oi’s. I’ll give a brief synopsis of Oi’s paper here with the intent of pointing out the parts that will be especially relevant to upcoming discussion of different university tuition pricing structures.

In the first section of his paper, Oi reaches the conclusion that if a supplier is going to be selling his product to people with a wide variety of individual demand curves, a two-part tariff pricing structure is optimal. The structure charges everybody the same price per unit, which is equal to marginal cost, but a different lump sum or entrance fee amount, which is equal to each individual’s consumer surplus. Oi goes on to say that this structure will increase the profits of the monopolist but is rarely seen in practice.
Oi later discusses a pricing structure used by IBM that uses the two-part tariff with a twist. This structure charges users a lump sum fee which allows them to purchase up to a fixed amount of hours. If they want more after that fixed point they have to pay some additional price per hour. Oi points out that this structure is only optimal under specific conditions. Those conditions are that the marginal cost of the unit is zero, re-sale of the product is impossible, and prices are set optimally.

3.2 Wu & Banker (2010)

Wu and Banker (2010) do a thorough examination of three pricing schemes used by a monopolist who provides information services. The three pricing schemes they examine are flat fee pricing, pure usage-based pricing, and two-part tariff pricing. In this paper we will examine the same three structures along with two other hybrids. Wu and Banker (2010) make several of the same assumptions this paper is going to make namely that the marginal costs are zero, customers can have different downward sloping demand curves, and the supplier is a monopolist. Their conclusion is the same as ours, that when customers are homogenous flat rate pricing is superior and that when customers are heterogeneous the two-part tariff becomes an optimal pricing structure.

This paper will take the ideas presented by Wu and Banker and relate them to the market of higher education. The two markets are quite similar and I will therefore be able to reach many of the same conclusions as Wu and Banker. The model they use is the same as my second model in which each consumer is treated as an individual with his own demand curve for units of an item.

3.3 Bryan & Whipple (1995)

Bryan and Whipple (1995) explore primarily the elasticity of demand held by current students to price increases. They try to determine the effect of a tuition increase on current students. They specifically investigate tuition elasticity at Mount Vernon Nazarene College. They estimate a function that predicts the retention rate of current students given some change in tuition by interviewing students and asking them if they would re-enroll or switch to some different school given some particular tuition increase. They conclude that as the
tuition increases fewer students will choose to enroll. I will not be exploring a question as specific as the one addressed by Bryan and Whipple. But I will be using their conclusion that the demand for education is downward sloping.

3.4 Carlton et al. (1995)

Carlton et al. (1995) examined what happened when the Antitrust Division sued the eight Ivy League schools and MIT for engaging in a conspiracy to fix prices. The paper ultimately finds that, while the schools did have an agreement, it did not affect the average tuition paid by students. The paper reaches several conclusions which will be significant for me. The first is that “the wealth of the student body has a positive effect on average price and is highly significant,” as this is an assumption I make later. The second is that the schools colluding did not, in fact, guarantee that they didn't price each other out of their surplus. This lets me verify my previously made claim that the schools can be treated as price makers.

3.5 Rothschild & White (1993)

Rothschild and White (1993) were responsible for a book chapter entitled “The University in the Marketplace: Some Insight and Some Puzzles.” The primary purpose of the chapter is to point out that there is a shortage of research that analyzes university behavior in a market context. They explore primarily professional schools but some of their insights and questions can be applied to undergraduate education. They ask why schools don't practice significant first degree price discrimination. Rothschild and White will also present the following idea – “an alternative model would be that of a two-part tariff in which customers are charged a lump-sum entry fee and are then charged prices for individual services that approximate marginal costs (Oi,1971)”.

This model inspired the second model I use in this paper. I will also present possible solutions to some of the puzzles presented by Rothschild and White. If these ideas have been explored in other more recent papers, I am unaware and will readily acknowledge those authors should the other papers be made aware to me.
4 Models

4.1 Model One

The first model this paper is going to use makes the assumption that students’ demand for education makes them either part-time or full-time students. Part-time students demand only one class, while full-time students demand five classes. Students also have different reservation prices for their respective product. My model will further assume that the students’ reservation prices are uniformly distributed between some lower bound and some upper bound. So if you line up all the students who want to be full time in order of their willingness to pay, the student who will pay the most to be full time will pay the upper bound and the student who will pay the least will pay the lower bound. Because distribution of the reservation prices is uniform, the aggregate demand curve for each market, the part-time market and the full-time market, will be linear.

4.1.1 Parameters

Our model will use the following parameters.

- \(p\) The price to be part-time which means taking one course
- \(q_p\) The quantity of part-time students
- \(f\) The price to be full-time which means taking five courses
- \(q_f\) The quantity of full-time students
- \(K\) The maximum number of credit hours the school can offer.
- \(c\) The cost of to the school of supplying a course
- \(a\) The intercept of the demand curve
- \(b\) The slope of the demand curve
4.1.2 The Model

Following our assumption in the model introduction to the model that the reservation prices were linear, we can write the following inverse demand curves for part-time and full-time education.

\[ p = a_p - b_p q_p \]
\[ f = a_f - b_f q_f \]

Our assumptions that aggregate student demand is linear, that schools are price makers, and that the part-time and full-time students can be treated as independent mean that the optimal \( p \) and the optimal \( f \) can be found using textbook monopoly pricing. Specifically, the school can price its products using classic third degree price setting techniques. The derivations can be found in the appendix.

For a part-time education the school will charge \( p^* = \frac{a_p}{2} \) and \( q_p^* = \frac{a_p}{2b_p} \) of the students in the part-time market will enroll. For a full-time education the school will charge \( f^* = \frac{a_f}{2} \) and \( q_f^* = \frac{a_f}{2b_f} \) students from the full-time market will enroll.

Remember that a full time student takes five courses, because the school has some maximum capacity the prices to be full-time and part-time are subject to the following constraint.

\[ q_p + 5q_f \leq K \]

If the school has sufficient capacity to enroll all of the part-time and full-time students that choose to enroll at the optimal prices that the school will charge those two prices. If however, the school does not have the space for that many students then the school must solve a third degree price discrimination with capacity constraint problem. It will have to decrease the quantity of students that enroll. To do this, the school will increase the price for the market segment that is paying the least amount per credit hour. It does this until either the quantity of students that enroll is less than or equal to the maximum capacity of the
school or until the marginal revenue from each type of consumer is the same. At this point the school will raise the price of each product to keep marginal revenue the same until the capacity of the school can satisfy the aggregate demand for classes.

4.1.3 More about $a$ and $b$

Both the intercept and the slope of the demand curves are influenced by several key factors.

4.1.3.1 Time

The first variable of importance is the amount of spare time the students have. If students are raising families or working full-time, they may not have the time necessary to take many classes. So if a greater proportion of the students in a market are busy, the aggregate demand curve will be steeper with respect to $q$ since the students will not be willing to pay a lot for their education since they have other things they need to do with their time. So, the amount of time the students have determines the slope of the aggregate demand curve. This is true for both market segments. Note that in extreme cases the amount of time students have might even cause students to move between the two markets, but I will not consider that in this paper.

4.1.3.2 Value on Education

Some students think very highly of education and will therefore have a very high reservation price for their education. The highest reservation price had by any student will set the intercept of the demand curve. And if, in the aggregate, many students have high reservation prices we’ll expect to see a shallow and high demand curve. If only a few students have this high value on education, the demand curve will be steeper. Again, this is true for both markets.

4.1.3.3 Wealth

Student wealth, and in many cases their family’s wealth, also affects the demand curves. Common theory suggests that having very wealthy students will increase the demand
curve's intercept and having many wealthy students will decrease the slope of the demand curve. This has been verified Carleton et al.

4.1.3.4 School Ranking

It is also worth looking not just at student, but also university characteristics. Schools that rank higher have a degree that is valued more highly. This means that students might have different reservation prices for different schools. That is, a student might value a degree from IU at some level, but then value the more prestigious Purdue degree more and therefore have a higher reservation price for a Purdue degree.

4.2 Model Two

Our first model made the assumption that students could take either one or five classes. A quick look at any university and its students shows that there are some students taking every number of classes. The second model choice assumes that there are thousands of students each with a demand curve for education that says how many classes that individual will take if the price per credit hour is a given price, as opposed to our model that uses an aggregate demand curve that predicts the total number of students that will sign up if the price to sign up is some given price. Using individual demand curves is the model used by Walter Oi (1971) in his Mickey Mouse Monopoly paper. For simplicity I will present just two full-time students to begin.
Figure 1 shows two students with demand curves $\Psi_1$ and $\Psi_2$. We are still assuming that marginal cost is zero.

The same student characteristics that influenced the parameters of the first model are relevant in this model. Instead of averaging the student effects though, this model treats each student differently. So a student can have a higher demand curve for a particular school's education if he has more wealth, more time, places a higher value on education in general, or really wants to attend that particular school. The curves can take all sorts of shapes which makes using this model to find the optimal price structure and then relevant prices for a school very difficult indeed.
5 Pricing Structures

With the assumptions laid down and two theoretical frameworks discussed, I will now describe the different pricing structures. Each structure is best used with a particular pair of part-time and full-time aggregate demands; or a certain make-up of students. The structures will be introduced in an order such that the first structure should have the greatest percent of part-time students and the smallest values of the $a$ and $b$ parameters for both curves while the last structure should have the highest percent full time students and then the greatest values of the $a$ and $b$ parameters. The other structures will fall somewhere in between.

For the purposes of this paper, no distinction will be made between in-state and out-of-state students at public schools. This paper is only concerned with structures, not specific prices, and for all two hundred top ranked schools in-state and out-of-state students are charged under the same structure. In the same line of thinking, we will be ignoring extra fees often charged by engineering and management departments within universities.

Finally, universities across the country have a very impressive amount of creativity when it comes to setting prices. If I had been extremely rigorous in recording every unique pricing structure I would have at least a few dozen pricing structures, from these two hundred schools alone. The following five structures I think do a fine job representing the different structures. All of the structures in use at some university are very similar to, even if slightly different from, one of the following five structures.

The format of the structure descriptions will go like this: I will describe the structure as it is in real life pointing out flat rate, lump sum, and hybrid parts of the pricing scheme along with an example of a school that uses that structure. Then I will describe some characteristics we expect to see of the students at a university that uses that structure along with some characteristics of the university. Finally, I will discuss how the structure fits into the frameworks of our models.
5.1 Structure One – The Flat Rate with Entry Fees

5.1.1 Description

The first pricing description I will explore is the flat rate with small entry fees. A flat rate pricing system charges some set rate per credit hour regardless of how many classes the student wishes to take after some small fees that must be paid after the student crosses some quantity of credit hours thresholds. The student payment function for this structure is this.

\[ P(j) = \begin{cases} 
  j \cdot p + k_1 & , \quad j < j_1 \\
  j \cdot p + k_1 + k_2 & , \quad j \geq j_1
\end{cases} \]

Total student payment is a function of the number of credit hours a student signs up for, \( j \), the price the school charges per credit hour, \( p \), and the small fees that the school charges, \( k_1 \) and \( k_2 \).

Note that this section includes schools that have varying numbers of fees. Some schools have one-time fees just at entry while some schools have new fees that get charged to students nearly every other class. \( P(j) \) is therefore just a representation of all the schools I’m saying use structure one. In other words some schools school have a \( k_1 \) and \( k_2 \) equal to zero while others also have a \( k_3 \) and \( k_4 \) in their pricing structure.

5.1.2 Examples

Oklahoma State University is a school that uses this pricing structure. They charge their undergraduates $136.75 per credit hour regardless of the number of credit hours they take. The school also charges many fees including the facility fee, transit fee, and activity fee, but these are all charged per credit hour. These fees are required if a student wants to take classes, so they are included.

Michigan State University uses this structure as well. They charge their students $371.75 per credit hours and a $5.00 one-time payment charged only to students who are enrolling in six credits or more.
This structure is also the current pricing structure in use at Texas Tech University. At Texas Tech, students are charged a base rate $50.00 per credit hour of tuition plus assorted other fees like library fees, IT fees, and business service fees that are also charged per credit hour. Texas Tech has other fees like the medical service fee and the student union fee that are charged per semester to students taking more than 4 credits, student service fees charged to students taking more than 7, and energy fees charged to students taking more than 12.

5.1.3 Price Graphs

![Marginal Price For Credit Hour](image1)

![Total Student Payment](image2)

The marginal cost for credit hour, shown in Figure 1, illustrates the extra fees that a student must pay to sign up for her first credit hour and the second fee she must pay to sign up for the next credit hour beyond the threshold. This is also seen in figure 2 which shows the total payment that she must pay to take some quantity of credit hours. The total cost curve jumps at that threshold since as a student wants to sign up for more classes she needs to pay an extra fee to be able to sign up.

5.1.4 Student and University Characteristics Suggested by Structure

One reason that a school might adopt a flat rate plan is that it offers a good deal of flexibility. That flexibility is valuable to students who need a long time to finish. It is flexible because it has the fewest disincentives to finishing slowly. Later, schools that charge a very high “entrance fee” will be examined. Those schools eventually incentivize out students who cannot finish in a timely manner. Since this structure has a very small entrance fee, it does not punish students for taking a long time to finish since they will be paying for
approximately 120 credit hours regardless of how many years it takes them to finish, since the extra fees are relatively small.

This flexibility will be useful to a school that is hoping to appeal to students with three main characteristics. The first students are those that don’t have a lot of spare time, either because of job requirements or family commitments. It is also a forgiving structure to students who struggle to pass, since they only need to pay for the class again, and not any sort of lump sum just to be able to sign up for classes again. It is worth pointing out that the benefits of this flexibility disappear if the flat rate is very high. But due to the kinds of students this school is hoping to attract, this will not be the case. The second characteristic of the students is that they aren’t very wealthy and therefore don’t have a very high demand for lots of classes. The third characteristic is that the students are often low achieving and not very motivated to do well in school. Students with any of these characteristics will be drawn to the flexibility of this structure. In some cases, students might even have to go to a school with this structure if they can’t afford the education at schools that use the later structures.

Let’s now examine the characteristics of a school that uses this kind of structure given that the students it will be enrolling are those described in the previous paragraphs. In general, these kinds of students are just looking to get a degree. They aren’t aiming for a brand-name degree of a thrilling, mind-expanding college experience as they don’t have the time or the academic stamina or both. Therefore, schools that ought to use this structure are those that have a low ranking and are hoping to appeal to students who are poor, low-achieving, or both.

With these student and university characteristics in place, we look at the final variable, the six year graduation rate. Both the kind of students and the quality of the school will influence this variable. We can generalize that the students don’t value education highly and aren’t particularly hardworking. Also, or possibly or, the students are poor and cannot afford to be at school full time. Finally, the school is not highly ranked which means the quality of the students is even further diminished since good students will look elsewhere. We conclude that schools that use this pricing structure will have a low graduation rate compared to schools that use different structures.
In terms of our first model’s parameters we expect to see a higher ratio of part-time students to full-time students than in the structures we will discuss next. We also expect low values of all the $a$ and $b$ parameters. Finally, since $p$ and $t$, are not calculated independently the amount the full time students must pay is $5p$. In terms of our second model’s parameters we expect to see lower shallower demand curves.

5.1.5 Producer and Consumer Surpluses under Model 1

The second to last sentence of the previous subsection is the important one about this structure. The university charges a flat per credit hour rate in this structure and therefore does not set two different optimal rates for its two different market segments. This is only an acceptable move by a university that faces full-time student aggregate demand that is approximately five times that of the part-time students, in which case the structure it uses doesn’t matter. If the optimal price for the full-time students is significantly greater than five times the part-time price, then the school would be better off if it used one of the following pricing structures.

A school that uses this pricing structure is therefore assuming that it can find the optimal price for the part-time market segment and charge five times that price to its full-time students. The consumer surplus for both markets will simply be the area between the demand curve and the horizontal price curve while the producer surplus is the area between the horizontal price curve and the marginal cost curve, which given my assumptions is the horizontal axis.

5.1.6 Producer and Consumer Surpluses under Model 2

A school that uses structure one could charge price $P$, from figure 1. This makes student 1 take $X_1$ classes and student 2 take $X_2$ classes. The school makes the area under $P$ while the students keep as consumer surplus the area $A_1B_1P$ and $A_2B_2P$ respectively. The school could alter price per credit hour to $P^*$ and therefore get the area under $P^*B_2$ and $P^*B_1$ as before while the students keep as consumer surplus the area above $P^*$ and under their demand curves, again as before. In structure one the school does charge some entry fees which will
capture a little bit of that consumer surplus. Maximizing the profit for a school means picking a P that maximizes the difference between the producer surplus under the P line and the consumer surplus between the demand curves and P. This is extremely difficult to do as a school would have to determine the demand curve for all the students attending.

5.1.7 An Incentive

I have discussed that this structure provides few disincentives to taking a long time to finish. It is interesting to point out that while this structure doesn’t pressure students to take a long time covering all the material, there are some schools that provide students with an incentive to not continually fail courses. Both the University of Central Florida and the University of Southern Florida have a significant surcharge that students must take if they are attempting a class for the third time.

5.2 Structure Two – The Flat Rate Part Time and Lump Sum Full Time

5.2.1 Description

This pricing structure is the one used by most of the top two hundred schools in the United States. This structure is the first we examine that offers an all you can eat part, but it’s only all you can eat after a point. Before that, students are charged on a per credit hour basis. The cost function for this structure can be seen below.

\[ P(j) = \begin{cases} 
  j * p , & j < j_1 \\
  K , & j \geq j_1 
\end{cases} \]

Some schools charge part time students per class while some charge per credit hour. As in the case of the last structure, the behavior of \( p \) is the same and if it represents one or three credit hours is not important. It is useful to think of the lump sum part of this structure as a two-part tariff with a zero cost for additional units.
5.2.2 Examples

Purdue University uses this structure. Purdue charges $324.75 per credit hour to in state students up to 7 credit hours. Starting at 8 credit hours, in state students are charged $4,296.20 and can then take as many classes per semester as they want for no extra costs.

5.2.3 Price Graphs

Both figures four and five show to great effect the zero extra cost to the student of taking a class after paying the lump sum. The idea is that students can take just a few courses and pay the per credit hour rate. After that small number of classes the students have to pay a large lump sum. This lump sum payment, however, allows them to take as many classes as they want to as there is no financial cost to adding more classes after paying the lump sum payment.

5.2.4 Student and University Characteristics Suggested by Structure

This is the first structure to use a large lump sum payment for its full time students as opposed to a per credit hour rate. Remember that although we treated the previous structure as having a lump sum for full-time students it was actually 5p and was part of a per credit hour rate structure. Schools might be influenced to use this structure as opposed to the previous one if the value of \( f \) is much higher than 5p. According to our discussion in the model section, there are four factors that can influence these parameters.
The first student characteristic that can influence the parameters is time. Having a greater amount of free time means that students are more likely to choose to be full-time as opposed to part-time students. We therefore plan to see more students choosing to be full time at a school with a structure like this. It's not the goal of this paper to say which came first. But a logical claim is that as more students are choosing to be full-time the schools are missing out on more consumer surplus by not charging them a rate independent of the part-time student’s rate. The specifics will be explained further in the next subsection.

The amount of value students put on their education can also influence both values $a$ and $b$. The reason for this is clear. As students value education more they are willing to pay more for it and the demand curve is therefore further from the origin. The wealth of the students and their families also influences all the same parameters in the same way. The increased wealth moves the demand curve outward.

Finally, the school rank will influence the kind of structure the school will be able to use. As a school switches from the first price structure to this one, the full-time students miss out on more consumer surplus. However, if the school is higher ranked, the students will be more willing to let that consumer surplus go as there are fewer alternatives and the school is more of a price maker.

Because of the lump sum nature of being a full time student, we expect the students to work hard to graduate quickly. We pointed out in the last section that at a school that had small or negligible lump sum fees the students faced no financial cost to taking a long time to graduate. While they do face an economic cost in the previous structure, there is an obvious financial cost to taking another semester. But at a school with this two-part structure, even if students only need three or four more classes they will have to pay the lump sum again (the exact cutoff depends on the specific school, of course). So students looking ahead can say well I could graduate in an easy 10 semesters, but if I just push myself a little harder I can graduate in 9 semesters and save myself that entire lump sum amount. Therefore, we expect to see that schools using a lump sum payment to have higher graduation rates. I readily point out that although this causal argument makes sense, it could also be that schools with this structure are made up primarily of higher achieving students, as discussed previously, who graduate faster anyway. Either way, we should definitely expect to see a
correlation. Overall, because of both the lump sum impact and the high quality of the students, we expect these schools to have higher graduation rates than the schools that used the previously discussed pricing structure.

With this information about the students we will revisit the school’s ranking. Schools with this structure are going to be higher ranked than schools that use the first structure. Whether the rank influences the quality of students that attend or the quality of students that attend determines the rank is not within the realm of this paper. But what we do know is that both of these are correlated with graduation rate. This set of things, time, wealth, value on education, and rank, all of which are correlated to each other, can tell us something about the pricing structure the university uses. In this case, the slightly above average quality of students suggests that the school uses this pricing structure.

5.2.5 Price Setting and Producer and Consumer Surpluses under Model 1

Schools that use this pricing structure set their prices exactly the way our model says that they should. The noteworthy characteristic of this pricing structure versus the last one is that $f$ is now more than $5p$. In real terms, schools that use this structure have a full time rate that is more than five times the price it would cost a student to take just three credit hours. This extra amount, the amount $f - 5p$, is the premium that students must pay to be full-time. They could take five terms and take one class each term and only have to pay $5p$, but instead they pay the amount $5p$ plus some premium to take those five classes in one semester. This is the analogous situation to the two part tariff $O_i$ introduced. In order for people to purchase amounts beyond some limit they must pay some lump sum fee in order to buy those extra units. The lump sum our students must pay is $f - 5p$. Note that this is different than the lump sum I talk about in model two.

The surpluses are again textbook. The consumer surplus for each segment is the area between the demand curve for that segment and that segment’s price, either $p$ or $f$. The producer surplus is the area below the price curves and the $x$-axis.
5.2.6 Price Setting and Producer and Consumer Surpluses under Model 2

In this structure, the part time students are treated like they would be in a normal price maker monopoly. A price is determined by setting the marginal revenue equal to the marginal cost and charging that price per credit hour to the part-time students. The part-time students will get to keep some consumer surplus and some will take two classes while some only take one and some others are priced out of the market and choose to take no classes.

For full time students the second model gives another way to think about the lump sum. Remember that the school switched to this structure because it wanted to capture more consumer surplus from its full time students. The school charges some lump sum to capture this consumer surplus. It has many options, but in the case of figure 1, just two sensible options. It could charge as a lump sum the area under the first student's demand curve. This would capture the entire surplus from the first student but price the second student out of the market. The other option is to charge as a lump sum the area under the second student's demand curve. This would keep the second student at the university and his entire consumer surplus could then be captured. But the first student, who also stays, would keep some consumer surplus. The optimal price for a school to charge becomes very difficult to find once many students, all with slightly different demand curves, enter the market. Some students will be priced out of the market while some others keep some of their consumer surplus and only a few pay their entire surplus to attend. The school will probably end up using a guess and check method as it sets a price and then sees if it fills to capacity. If it does, it raises the price and if it doesn't, it lowers it. It is this process we are seeing all over the country today as universities are trying to determine how much they can charge and still fill their classrooms.

5.2.7 An Incentive

The University of Minnesota uses this pricing structure. On their website they tell students, "Each semester, every credit after 13 is free of charge, keeping costs down for families and helping students achieve graduation in four years." Schools are well aware of the implications that using this pricing structure can have on students taking many classes.
Minnesota is now acting not as we assumed they would: in a way that would maximize their surplus. This example illustrates that there are some schools that are acting, or claim to be acting, in the best interest of their students.

5.2.8 Transition

In our model we have been assuming that students can take only two different numbers of classes. However, in reality, there are students who want to take even more than fifteen credit hours. Schools with this pricing structure work under the assumption that these high achieving students will attend other higher ranked institutions and thus don’t alter their pricing structure. However, sometimes the number of students that want to take even more than fifteen credit hours is so great that schools adjust their pricing scheme.

5.3 Structure Three – The Flat Rate Part Time and Lump Sum Full Time with a Surcharge for Extra Hours

5.3.1 Description

At the end of the last structure I pointed out that students at a school with that structure could abuse the system and take many classes beyond a certain point with the only cost being their time and energy. Some schools that are prime candidates to use structure four have reached this conclusion as well. Therefore they have altered the previous structure slightly by having an all you can eat buffet only up to a point. After that point, students must may per credit hour again. The cost function for this structure reads as follows.

\[ P(j) = \begin{cases} 
  j \cdot p_1, & j \leq j_1 \\
  K, & j_1 < j < j_2 \\
  K + (j - j_2) \cdot p_2, & j \geq j_2
\end{cases} \]

5.3.2 Examples

A school that uses this structure is the University of Indiana. Indiana charges $241.10 per credit hour for the first 11 hours. Starting with the 12\(^{th}\) credit hour, the student becomes a
full time student and is charged $3,861.00 to take anywhere from 12 to 17 credit hours. Unlike the previous model, the 18\textsuperscript{th} credit hour now does have a marginal price. It will cost a student at IU an additional $241.10 per credit hour on top of the lump sum payment to take more classes.

5.3.3 Price Graphs

As expected, these graphs are the same as the graphs of the previous structure until the number of credit hours exceeds the number a student can have in the all you can eat buffet. Then there is again a cost per credit hour. Also, the total cost again begins to increase as students have to pay more for classes.

5.3.4 Student and University Characteristics Suggested by Structure

In examining the student characteristics suggested by this structure we’ll look again at their wealth and high school achievement. Since the schools felt it was necessary to implement an extra charge on people who take many classes, we imagine that some students split off from the full-time students and make their own super-time student aggregate demand curve. Students in this demand curve are generally wealthier than people with the earlier demand curves. They also place a higher value on education and are academically motivated. Therefore, nothing is stopping these students from taking many classes, which causes the school to change its pricing structure.

The school, since it does have a part time rate in its pricing structure probably also has either enough capacity to enroll some part-time students or a high enough relative part-time
rate that enrolling part-time students is still profitable. It is worth noting at this point that we cannot make any surefire conclusions about the achievement of part time students. It's possible that the students have the low demand curves simple because of time problems with jobs or family or because of money problem. There is a difference between these students and those that are attending the schools that use structures one and two. That is, these students are attending a school that has a significant number of high achieving students which suggests that the classes are more challenging than those we saw in the first two structures.

Given that the school has students who generally have greater amounts of intelligence and motivation, we expect the ranking of the school to be higher as well. Higher, that is, than schools using the previous structures. In conclusion, because of the student quality and their demand curves, the school is expected to have a decent, but not great, graduation rate. There are some students that are signing up for more classes than average and really flying through school, but there are also people there who are taking fewer classes, as indicated by the structure’s having a part time rate.

5.3.5 Price Setting and Producer and Consumer Surpluses under Model 1

The pricing for the part-time and full-time students is exactly the same as in the previous structures. The consumer and producer surplus for these two markets is also the same. In this structure, however, our model adapts by adding a new demand curve for a sixth class. The demand curve for this sixth class is similar conceptually to the part-time demand curve. The students in the full-time market all have some reservation price for taking a sixth class. The sixth-class aggregate demand curve is the curve of these reservation prices. The curve tells us how many students will opt to take a sixth class given a certain price for that sixth class. The school sets this price first in a vacuum according to monopoly pricing. Then it follows the same process as before – if the school has the capacity then the prices stay there, if the school doesn’t then the prices increase such that the market paying the most per credit hour is the last to feel the constraint.
5.3.6 Price Setting and Producer and Consumer Surpluses under Model 2

Under the second model this price structure is very similar to the last one except that a new price $P^{**}$ is charged per credit hour to students wishing to take more than their lump sum status affords them.

In the last structure we pointed out that student 1 and all students with a demand that exceeded the lump sum amount would get some consumer surplus. In figure 8 the school has decided to charge a lump sum that keeps both students in the market, namely the amount under the second student's demand curve. In an attempt to capture some of the first student's consumer surplus the school charges some per credit hour rate that makes the student with the high demand curve pay for the extra classes. In this case student one pays the lump sum, the area under the second students demand curve, and also an amount $P^{**}$ times the number of classes he takes above $X^{**}$.

5.3.7 A Disincentive

Northwestern University uses this structure as well. They charge a $13,280 lump sum for students who want to take 3 or 4 courses (note that Northwestern uses the quarter system, so
a full load is three or four courses). There is also a part time fee of $4726 per quarter, but only a few hundred students are part-time. By the definition of structure three, Northwestern has a max on the number of courses at 4, and then if students want to take more than that they must pay an additional $3320 per course. Now for the disincentive: Northwestern also has a requirement that nine quarters be spent at Evanston enrolled as a full time student. This added rule makes it very clear that Northwestern and other schools using structure three are trying to extract consumer surplus from their students. They want to prevent want Minnesota was encouraging and force their students to stay as long as possible so they can collect as many lump sum fees as they can.

5.4 Structure Four – The Two-Part Lump Sum

5.4.1 Description

This structure is just what it sounds like. Instead of charging a per credit hour rate to part-time students, schools that use this structure charge a small lump sum to students only interested in taking a few classes, and then a different, larger lump sum to students who want to be full time. The cost function for this structure is:

\[ P(j) = \begin{cases} 
K_1, & j < k \\
K_2, & j \geq k 
\end{cases} \]

5.4.2 Examples

The Georgia Institute of Technology uses this structure. Georgia Tech charges its part time students, those who take six credit hours or less, $2,100. All other students, those who take more than six credit hours, are considered full time and are charged $3,535.
5.4.3 Price Graphs

These graphs demonstrate the nature of the two-part lump sum. Students pay one entrance fee for an all you can eat buffet. If they are still hungry they have to pay another one-time fee to go back through the line.

5.4.4 Student and University Characteristics Suggested by Structure

These students differ from those in the previous structures most notably in the quality and quantity of their part time students. We expect a school with this structure to have part time students who are more motivated to do work. We expect this because something made the school use this structure instead of one of the previous ones. I claim that it is because the part-time students had higher demand curves, and the student characteristics that come with that. It is also likely that they have a higher demand for education but that they just don’t have time to be full-time students.

5.4.5 Price Setting and Producer and Consumer Surpluses under model 1

Schools that use this pricing structure set their price using the same model as we’ve been using. And the surpluses are the same. Note however, that Georgia Tech in our example is charging its part time students more per credit hour than its full time students. It’s possible that the school has decided to use a structure influenced by the idea of second degree price discrimination. More likely, though, the public Georgia Tech is facing pressure from its government to have a lower than \( f \) rate for its full time students. An analysis of this is outside the realm of this paper, however.
5.4.6 Price Setting and Producer and Consumer Surpluses under model 2

The idea is similar to what I've talked about before in that schools must pick some price knowing that some students will be priced out of the market and some will keep some of their consumer surplus.

To clarify, the school knows which group of students it's selling a particular product to. In other words, it's impossible for a student to simply buy a full-time and then sell two part-times. Similarly, in the previous structures the students have never had the option to simply buy five part-time classes and then save on the lump sum payment.

5.5 Structure Five – The Pure Lump Sum

5.5.1 Description

The final structure is one that charges a lump sum that allows students to take as many courses per term as they want. This all you can eat buffet structure means that schools are planning to fill their capacity with all full-time students who are paying more per credit hour than any part-time students would. The schools have decided that there is no loss to pricing those students out of their school. Instead they have decided it is optimal to enroll, and charge tuition to, only those students that are interested in being full time students.

5.5.2 Examples

Harvard University uses this structure. They charge a lump sum fee of $38,300. This fee will allow the students to take all the classes they want. Unlike the previous structures, there is no rate for part time students. If a student wants to take just one class at Harvard he will have to pay the entire $38,300 tuition fee.
5.5.3 Price Graphs

These graphs both illustrate the constant total cost. Regardless of the number of credit hours students take, they will be charged the same rate. The students must pay the entire lump sum fee for the first credit hour and then the rest are all free. The graphs clearly demonstrate that in the lump sum structure students are faced with a markedly different set of incentives from the first few structures. Students have an incentive to take more classes per term than they would if they were facing a constant per credit hour rate since in this structure they are paying per term as opposed to per credit hour.

5.5.4 Student and University Characteristics Suggested by Structure

In this structure we expect to see only full-time students and we expect the aggregate demand curve to have a high intercept and a shallow slope. It is possible for students at these schools to take a small number of credit hours and be considered part-time, but they must pay the same lump sum as everyone else.

Remember that with reservation prices as high as these students’ are, a high amount of wealth is likely playing a part. This paper does not intend to get into the does wealth cause high education or the other way around. But whichever comes first, we still expect that the students at schools that use this pricing structure will have been successful in high school. This is also because the students making this aggregate demand curve have more interest in and capability of doing well in school.
We expect that schools using this structure and being highly ranked will be strongly correlated. Schools that use this structure enroll students who are wealthy, which suggests they and their families value education, which suggests they will do well, which suggests the schools will be highly ranked. Coming the other way, schools that are highly ranked can be selective about the students they admit, which suggests they will be able to enroll students who are intelligent and wealthy, which means it will be optimal for them to use this pricing structure.

Due to the high lump sum cost effect, the fact that students can take as many classes as they want after paying that lump sum, and that the students at these schools are successful and motivated, we expect the school’s graduation rate to be higher and faster than at other schools. Students would rather not pay a lot of money for their education and will therefore try to finish as soon as is reasonable. We do not make the claim that students will be trying to finish in two years. But they will be trying to get out and on with life quickly as opposed to students at schools that charge tuition on a per credit hour basis and whose students therefore have no financial costs to staying a long time and then often do so.

5.5.5 First Degree Price Discrimination

Our assumption about financial aid is also very far from the truth. It is clear to anybody familiar with college pricing that financial aid has a major role to play. In his 1971 paper Oi writes “The best of all possible worlds for Disneyland would be a discriminating two-part tariff where the price per ride is equated to marginal cost, and each consumer pays a different lump sum tax. The antitrust division would surely take a dim view of this ideal pricing policy and would, in all likelihood, insist upon uniform treatment of all consumers.” This is exactly what schools that use this pricing structure are able to do. The price per credit hour at these schools is equal to the marginal cost, which is zero. Each consumer pays a different lump sum tax, thanks to financial aid. What these schools are able to do is charge some arbitrarily high price, significantly above $f^*$. They then collect information from families in the way of FAFSA forms and other scholarship applications. With these in hand, the schools are able to determine the reservation price for each individual and set a specific $f$ for each student they admit. In other words, these schools are able to perfectly first degree price discriminate and capture the entire consumer surplus.
5.5.6 Price Setting and Producer and Consumer Surpluses under Model 1

Price setting, as discussed in the last sub section, is completely arbitrary so long as the price is high. Model one explains the prices charged to each student in that the students get financial aid in the amount that brings the price down to their exact willingness to pay.

5.5.7 Price Setting and Producer and Consumer Surpluses under Model 2

Model 2 also shows this first-degree price discrimination idea in that each student is charged exactly the amount under his demand curve.

5.5.8 Camp Stanford

So far I've introduced a few reasons that students might have higher reservation prices or why one student's willingness to pay might be higher than another student's. I've also pointed out that for the same student, an education at one intuition might be valued more highly than an education at a different institution. I hypothesized that this is because the first school might be ranked more highly than the second. But there are likely some other reasons too. Highly priced schools often say that attending those schools will allow a student to make important, professional relationships, build her cultural awareness, and enjoy the other benefits that simply being on the campus affords her.

In terms of the second model, it is this being on campus that students are paying for with some of their lump sum. At a place that doesn't have a large lump sum, the students are paying more for the classes and less for the experience. But when the experience, as opposed to just the classes, starts to become a more important part of the school's offering a larger lump sum, or entry fee, makes sense. Some schools even have programs that allow students to pay to attend even though they aren't taking any classes.

At Stanford University, seniors who have finished their course requirements, but are still benefiting from being on campus, are eligible for Camp Stanford. This allows them to pay $3900 for the quarter (Stanford is on the quarter, not semester, system) and entitles students
to room and board but does not allow them to sign up for classes. What we see is some students paying for only the right to be on campus. As Stanford's paper puts it, "In the middle of the quarter, it might be difficult to imagine what life at Stanford would be like if classes weren't part of the equation. Time could be spent exploring hobbies, spending time with friends and basking in the sun during midterms while students fill Green and Meyer Libraries. For some, like Leah Karlins '11, this dream life on the Farm is real, and it's known as 'Camp Stanford,' or more formally, the post-graduation quarter" (Omer, 2011). Clearly, there is evidence to support that at some schools students are paying just for the right to be there and not necessarily only the classes.

6 Data & Results

6.1 Explanation of the Data

Throughout the paper I have been referring to five main variables. As a reminder, those variables are the demand curve of education for students either aggregate or individual, the intelligence of the students, the wealth of the students and their families, the ranking of the universities, and the graduation rate of students from the universities.

Some of these variables are very easy to measure. The ranking of the universities is taken straight from the US News & World Report. It goes without saying that there is a lot of debate as to the accuracy of the rating, and what exactly it means. This is not within the realm of this paper. I am using the ranking merely as an indication of the quality of the university. Graduation rate is another very easy variable to observe. Schools publish their four, five, and six year graduation rates. This paper will use what has become the accepted comparative graduation rate, the six year graduation rate.

The information about students is a lot more difficult to turn into nice quantitative variables. Demand curve for education is going to be represented by a weak proxy, the percentage of students at the university who are part time. Unfortunately, I could not find data on the number of students enrolled for each amount of credits at any university, let alone all of them and the number of part-time students was both readily available and somewhat related
to the students demand for education, at least how many students demanded just a part-time education.

Measuring the intelligence of the students has its own massive body of literature, a body of literature which has managed to be entirely inconclusive. Again, schools do not publish data on the individuals at their universities, so I will be using the 75th percentile of the composite ACT score as a proxy for the intelligence of the students at the university.

Finally, the wealth of the students and their families, while easy to measure, is unavailable to the public. I use the percent of students who borrowed through federal loan programs. This statistic was easy to find and also clearly related to the wealth of the student body.

I want to emphasize that this paper’s function is to present different pricing structures and analyze their theoretical implications. It is not meant to be an econometric paper analyzing the effects of these structures on their students or the effects of students on their universities pricing structures. I feel this way because of, among many things, the obvious endogeneity of all five of our independent variables and the completely made-up-by-me nature of our dependent variable. Therefore, I hope to point out some interesting trends and patterns, and nothing more.

6.2 Patterns & Trends

![Figure 13 - Ratio of Students who are Part Time](image1)

![Figure 14 - Average Ratio of Students who are Part Time](image2)
Our first variable is the ratio of part time to total students. While the graphs are not particularly compelling either way, we do notice that as the structure number of the schools increase, the ratio of part time to full time students decreases.

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<td>5 0.16462</td>
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*Figure 15*

Figure 15 shows the values of the two-tailed t-test between two groups with the null hypothesis that the two groups have the same mean, assuming unequal variances. Because there are very few schools using the fourth structure, we cannot say much about them. But we do notice a significant difference between some of the other groups, especially the first three structures as compared to structure five.

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*Figure 18*
The ACT score variable, which is a proxy for student intelligence, seems at first glance to have little to do with the structure a school uses. Upon further examination using t-tests, this is true, with the exception of structure five which from now on is always going to be significantly different from the others. I think, though, that the main problem isn’t the theory, but the variable. I think that the 75th percentile for the composite ACT score at a school is a really weak proxy for the intelligence of its students. Alternatively the intelligence of the student body might not be that highly correlated with ranking, which, skipping ahead to figure 20, is clearly correlated to the structure. That topic, while interesting, is also outside the realm of this paper.

There does seem to be a trend between the percent of students on federal loans, which remember is the proxy for student wealth, and the pricing structure used by the university. This goes very well with the theory that predicts that schools will pick a higher pricing structure if its students are wealthier since the higher pricing structure extracts more consumer surplus. Also, these wealthier students tend to value education more and therefore are willing to part with more money for an education.
There does seem to be a trend between ranking and structure used. The schools that use structure five are again quite obviously following the trend. I hypothesize that the schools that are ranked incredibly highly are very powerful price makers and are able to set their prices, and in this case admit who they want, such that they are able to extract a lot of consumer surplus. So we see that schools with structure five use that structure because it extracts the most consumer surplus, which wealthy intelligent students have the most of under monopoly pricing structure, which causes these schools to be very highly ranked.

Our final variable also doesn’t have a very strong correlation with the pricing structure. Again we see that structure five has a higher graduation rate than the others. Whether this is because of the structure and the powerful lump sum effect is a matter for another paper.

Overall there do appear to be trends between the structure and the variables. It could be that the structure is influenced by the student and university characteristics or it could be the other way around. Then again it could be that some other factor or set of factors is
determining both the characteristics and the pricing structure. The point of this section, again, is not to do a thorough econometric analysis but merely illustrate some interesting things.

7 Conclusion

In this paper I strove to introduce some background on the topic of different university pricing structures. I presented the different structures used by the top schools in the United States and what I hypothesized might be some of their students' characteristics and some of the schools' characteristics. I used some simple scatter plots to demonstrate that there does seem to be a correlation between the structure the school uses and those characteristics.

I also presented two simple models that can be used to help universities determine an optimal structure and set their optimal prices. The first model makes several very major assumptions the most notable being that students can take only three of fifteen credit hours while the second was more accurate but harder to derive useful information from. I then used these models to analyze the different structures. Throughout the paper I relaxed some of our assumptions about the number of courses students can take and the availability of financial aid. This allowed for a richer discussion of the pricing structure.

This paper leaves many questions unanswered. These questions include such econometrics questions as does the structure a school use cause students to graduate faster, take more or fewer classes, or pass classes at a higher rate than a different structure would. Also left to be explored is what happens when we increase the reality of our model by including things like state regulations, merit based aid, a non-zero marginal cost to the school to adding more classes, the differing availability of adjunct professors, graduate schools and subsidizing graduate students, and distance learning, just to name a few. Determining an optimal structure and price or prices within that structure is a clearly determined by many things and has many effects on many different sets of people. It is a complex problem that this paper hopes to introduce.
References


Appendix

**Derivation of** $p^*$

Since the demand curve is a straight line, the curve for the marginal revenue will intersect the x-axis at exactly half the quantity of the demand curve. Using the inverse demand curves for full-time students we get the following marginal revenue curve.

$$MR = a_p - 2b_p q_p$$

Since we have a zero marginal cost, setting this equation equal to marginal costs yields the following.

$$0 = a_p - 2b_p q_p$$
$$2b_p q_p = a_p$$
$$q_p^* = \frac{a_p}{2b_p}$$

Plugging this value of $q_p$ into the inverse demand function gives this.

$$p^* = a_p - b_p \frac{a_p}{2b_p}$$
$$p^* = a_p - \frac{a_p}{2}$$
$$p^* = \frac{a_p}{2}$$

**Derivation of** $f^*$

The derivation of $f^*$ is the same as that of $p^*$.

$$MR = a_f - 2b_f q_f$$

Since we have a zero marginal cost, setting this equation equal to marginal costs yields the following.

$$0 = a_f - 2b_f q_f$$
$$2b_f q_f = a_f$$
$$q_f^* = \frac{a_f}{2b_f}$$

Plugging this value of $q_f$ into the inverse demand function gives this.

$$f^* = a_f - b_f \frac{a_f}{2b_f}$$
$$f^* = a_f - \frac{a_f}{2}$$
$$f^* = \frac{a_f}{2}$$