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Empirical analysis of the demand for higher education, 1966-1990

Darin Ray Wohlgemuth
Iowa State University

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by

Darin Ray Wohlgemuth

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ABSTRACT

This thesis examines the factors that influence college enrollment at two levels of aggregation. The first model looks at enrollments by state. The second model explains enrollments at an individual institution, Iowa State University. A model similar to Becker's human capital investment model is used in this empirical analysis. Many of the results of the OLS regressions are consistent with economic theory and previous research. They indicate that education at both levels of aggregation is a normal good. The results also indicate that increases in tuition will lead to less than proportional decreases in the state-level enrollments. However, an increase in tuition at an individual institution, will lead to at least a proportional reduction in institutional nonresident enrollment. This would imply that ISU might realize significant increases in nonresident tuition revenues from a decrease in the cost of attending Iowa State.

CHAPTER 1

THE DEMAND FOR HIGHER EDUCATION

The demand for higher education is becoming an important area of analysis for many colleges and universities. College administrators, and state and federal planners must all be correctly informed about how college enrollments respond to changes in various factors. Increases in tuition over the last decade have potentially had a significant impact on the number of enrollees in some U.S. colleges. Other colleges may get more enrollees if their tuition rises less rapidly than competing institutions. There may be substantial increases or decreases in revenues as a direct result of the policy governing tuition levels. Policy makers and administrators must be informed about the responses of enrollments and revenues to their decisions.

The demand for higher education at a national level may have direct implications for the "National Service Plan" that is being proposed by the Clinton administration. It is clear that one of the goals of this plan is to have educational opportunities available for all persons. However, rapid increases in the cost of education have not aided the process of making an educational opportunity available to individuals or families with low incomes. It is important to determine how much enrollment has declined as a result of increases in tuition. It may also be helpful to examine the various effects of decreasing the total cost of education by awarding scholarships, grants, and deferred payment loans. The reduction of net cost through the awarding of grants or scholarships may increase enrollments more than the same decrease in tuition, due to the sense of achievement from being awarded a scholarship.

The impact of changes in family or individual income would also be an important issue to address. A governmental policy that would increase the income of families, perhaps through tax credits, if they had a child in college may aid in encouraging educational

opportunities to those with lower incomes. Again the impact of such a program can be analyzed with the framework of a model for the demand for higher education.

Current cyclical economic conditions may also factor into the decision to enroll in college. Does the current unemployment rate negatively or positively affect college enrollments? If higher unemployment rates lead to higher levels of human capital investment, efforts to combat short-term high levels of unemployment may lead to declines in enrollment in higher education. Since higher education is strongly negatively correlated with low levels of unemployment, high current unemployment could lead to lower long-term unemployment rates through increased human capital investments.

A related question is the speed with which college enrollments respond to perceived increases in returns to skill. Theoretically, a demand shift toward more skilled labor should imply an increase in enrollments. An individual who is deciding to attend college may use a measure of the increased salary of college graduates relative to high school graduates in his decision process. If a high school graduate does not see a significant increase in income or other benefits following college, then he may choose to enter the labor force rather than attend college. This measure of the increase in income from attending college, called "returns to education", is very likely to be a significant factor in an individual's decision. He will decide to attend college if the benefits outweigh the costs.

These factors become even more important when the scope is narrowed and we examine a single institution in light of other competing institutions. To remain competitive, a university must examine its own policies in light of its competitors. The institution will also need to consider the different markets in which it competes. A public university will be competing for students in several markets simultaneously. These markets can be classified into three categories: institutions in the state, institutions outside the state, and private institutions. These three markets are likely to be distinct due to the vast range of tuition

prices charged by the various institutions. Within the state, a university will be competing with other 4-year institutions, two-year institutions, vocational schools, and private institutions. However, relative tuition prices among these competing institutions may be nearly constant over time, except for the in-state private schools. The reason is that a central governing body such as a Board of Governors or Regents may dictate a fixed relative tuition among the public institutions of higher education within its jurisdiction. The out-of-state market will also have the same types of schools competing for students. However, there is much more variation in the relative prices faced by students opting to attend institutions in other states. The student that leaves his home state will be faced with nonresident tuition that is at least three times the in-state level. Therefore, the public university outside the student's home state will be competing at a price disadvantage. The reactions of the various markets are not necessarily the same. Nonresidents and those who are considering private school may be more sensitive to increases in tuition than are resident students, especially in the high range of nonresident tuition. At higher prices, demand generally becomes more elastic.

Each individual institution must consider how to recruit prospective students in each market. This study will use Iowa State University (ISU) as a representative institution. ISU, a land grant college, is the second largest university in Iowa. Three of its largest programs are engineering, business and agriculture. ISU is located in Ames, Iowa and is in the Big 8 athletic conference.

Iowa State University is now faced with possible policy changes that may have a direct impact on the enrollment levels. Iowa State has seen double digit tuition increases over the past decade. It has also seen significant changes in enrollments. The time paths of nonresident enrollment and nonresident tuition, which will be discussed in more detail in the following pages, indicate that real revenues from nonresident tuition have decreased significantly since the mid 1980s. Figure 1.1 shows a 1 million dollar decrease in revenue over

the past 5 years. Iowa State is facing budgetary pressures at both the state and federal levels that suggest that the governmental support is unlikely to increase at the past rates. As a result, developing strategies to increase revenue from tuition is becoming increasingly important.

Of particular concern to maintaining or increasing tuition revenues is the need to attract out-of-state students. These students pay approximately three times the tuition of in-state students. Iowa State University nonresident tuition levels are the second highest in the Big 8, behind only the University of Colorado. The University of Missouri is $500 lower while three of the other schools range up to $1,000 below Iowa State tuition levels. Although Iowa State's nonresident tuition is below the levels of the Big 10 schools, the gap is not large. Wisconsin, Iowa and Illinois have nonresident tuition within $700 dollars of Iowa State. Purdue, Ohio State, Minnesota and Indiana are within $1,300 of the ISU nonresident tuition level.

The goal of racial diversity on campus also increases the need for out-of-state students. Iowa has a very homogeneous population, so a large number of minority students must come from out of state in order to create racial diversity. The past decade of tuition increases has not helped in recruiting minority students, even though the number of minority students on campus has increased by 400. Another factor influencing ISU enrollment is the long-run decline in the number of Iowa high school graduates. In light of this decline, ISU must focus on out-of-state students to keep enrollment levels from declining.

As has been stated, the need for correct information about the impact of policies and economic factors on enrollment is crucial for planners at the institutional, state and federal levels. They must be informed about how their decisions are likely to affect enrollment and revenues. This thesis will examine aggregate enrollment patterns at a national level as well as at the institutional level. The conclusions and implications of this study may have significant

impacts on enrollment as well as revenues for the institutions of higher education who choose to consider them in their policy formation.

Overview of Enrollment, Eligible College Populations and Tuition Levels

It may be helpful to examine various time paths of costs and enrollment for institutions of higher education in the U.S. Figure 1.2 shows how first time freshmen enrollment in all institutions have changed over the past quarter century.[1] Notice that there have been significant changes over time. It is the purpose of this paper to determine what is driving the changes in enrollment. Notice that the time paths indicate two peaks, one in 1975 and a second in the years 1980-81. The peak level in both periods was approximately 2.5 million new freshmen. Since 1980, the number of first time freshmen declined until 1987. There was a slight increase in 1988, but this was followed by another downturn. The 1990 level was almost 2.3 million. The United States has seen a decline of 200,000 students entering college over the last 12 years.

Figure 1.3 shows the time trend of new fall enrollments of U.S. residents at Iowa State University. Again there are two peaks in this time trend. However, the peaks in 1977 and 1984 are slightly later than the national enrollment peaks. The number of new fall enrollees at ISU has been as high as 5,600, but has now fallen to its lowest level in the past 20 years. In 1992 the number of new fall enrollees was only 4,800.

Of more interest is the number of new fall enrollees that come from outside the state of Iowa (see Figure 1.4). Notice that there is a single peak over the past 20 years, in 1983. This peak level of 1,600 students is almost 500 students greater than the most recent 1992 figures. If ISU was able to increase enrollments to the 1983 level at 1991 nonresident tuition prices, this would translate into an immediate increase of $3.2 million dollars the first year.[2] If the

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[1]This is data for the nation as a whole. Comparable data was not broken down by state, and is not used in the empirical analysis which follows.

[2]Nonresident tuition in 1991 was $6,406 per year.

increase in first year students can be sustained through successive classes, this corresponds to an increase of 2,000 nonresident freshmen, sophmores, juniors, and seniors. The additional tuition revenues would be in the $12 million range per year. It should be clear that the demand for ISU nonresident enrollment is a significant component of the revenues of the university.

The task at hand is to establish the factors that are causing these changes in enrollment levels. To begin this examination, it is useful to first examine the number of high school graduates in the eligible population. The college student population has shifted toward an increase in the number of "nontraditional students". However, the number of nontraditional students has yet to make up a majority of students. As an example, in 1992 only 12.3 percent of the undergraduates at ISU were over 25 years of age. However, the percentage of undergraduates that entered ISU directly from high school was 68 percent in 1992.[3] Therefore, much of the recruiting and marketing efforts are directed at recent high school graduates. This demographic group takes up by far the largest share of university enrollment. Figure 1.5 shows the time trend of high school graduates. The early 1960s saw the most rapid increase in the number of graduates as the baby boom generation began to go through high school. After 1965, the rate of growth was slow and fairly stable. The number of high school graduates increased until 1977. In the early 1980s, the number of high school graduates began to decline more rapidly than in the late 1970s, but the number of graduates leveled off at about 2.3 million in the second half of the decade.

The number of high school graduates from Iowa exhibits a similar pattern. The time trend has a single peak in the early 1970s followed by a decline in the mid 1980s. A comparison of the time trends of high school graduates (Figure 1.5) and new enrollees (Figure 1.2) implies that some of the decline in enrollments may be attributed to the decline in the

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[3] *Iowa State University Enrollment Services Annual Statistical Report*, 1992

number of high school graduates. However, careful examination shows that the correlation between the two is not perfect. The second peak in enrollments came in a period of declining high school populations while the first peak came when the number of high school graduates was near its peak. Therefore, there must be other factors influencing enrollments.

One of these factors may be the price of college attendance. Although there are many direct and indirect costs of attending college, it is reasonable to examine the tuition changes over the time period of interest. The time paths of average real in-state and real out-of-state tuition for the United States are shown in Figures 1.6 and 1.7. In-state tuition peaked in 1973 and again in 1990. However, it is premature to imply that tuition has begun a downward trend. The data for 1992 and 1993 is not yet available. The enrollment level is hypothesized to be negatively related to the tuition rates. This implies that one might expect the time trends to move in the opposite direction. However, in the late 1960s and early 1970s both tuition and enrollment were increasing. Over the next decade, tuition levels decreased to a 30 year low in 1980. Note that this corresponds to the second peak of national enrollment. Following the low tuition level in 1980, tuition rates began to increase and enrollment began to decline.

The time path of out-of-state tuition is similar to the time path of in-state tuition. With out-of-state tuition, there are two peaks in the 30 years shown. The first, in 1973, is at a level far below the second peak. The second peak appears in 1990. It is, again, premature to infer that this is the end of the increasing trend since the data after 1991 is not available. In 1980, both of the tuition paths indicate record low levels of real tuition. Even though the time paths are similar, the range in which the two time trends vary are distinctly different. In-state tuition varied between a low of $1,000 and high of just over $1,450.[4] The out-of-state tuition varied between $2,000 to just over $4,500. Notice that the out-of-state tuition passed the previous maximum of 1973 between the years 1983 and 1984. This implies that the cost of out-of-state

[4]in constant 1987 dollars

education has increased substantially over the last 10 years. In-state tuition passed the previous maximum of 1973 in 1988. So the cost of in-state education has decreased relative to out-of-state tuition.

Another competitor in the educational market place is private colleges and universities. Figure 1.8 shows that average private college tuition has doubled in real terms, from a low of $4,000 in 1965 to a high of near $8,000 in 1992. The trend is still increasing. In all three tuition series examined above, the 1980s was a period of rapid increases. It is likely that this rapid increase may have had something to do with the decrease of 200,000 first time freshmen in the U.S. from 1980 to 1986.

As before, we will examine the time trend of Iowa State University, as a representative university. Figure 1.9 shows the trend of real ISU nonresident tuition. This seems to have a similar trend the national average nonresident tuition. There is a peak in the early 1970s, followed by steadily decreasing real tuition until 1980. Thereafter, there were rapid increases in real tuition levels for nonresidents through the 1980s. The rapid increase corresponds to recent decreases in out-of-state enrollment at Iowa State (Figure 1.4). This is yet another example of the possible connection between enrollment and tuition. Figure 1.10 shows both the national average and ISU nonresident tuition. The similarity in the time paths is quite evident, particularly in the last two decades. Only relatively recently has ISU nonresident tuition been at or below the national average.

Comparing the time trends is a good method to formulate hypotheses about which factors affect college enrollments. However, the direct impact needs to be determined by statistical analysis. This requires that a framework to examine these factors be specified. The statistical analysis done in this paper will determine the extent to which changes in enrollment can be attributed to changes in tuition.

Theory of the Demand for College Education

The theoretical model of the decision to attend college stems from Gary Becker's 1964, *Human Capital*. For the purposes of the current research the theoretical framework is developed by comparing the present values of two income steams net of human capital investment costs.

Let

$$y_i^c = y_i^c(he, ec)$$
$$y_i^h = y_i^h(es, ec) \qquad (1.1)$$
$$c_i = c_i(dc, es, he, ec, y_i^f)$$

where

y_i^c = income stream of individual i, given i completes college[5]

y_i^h = income stream of individual i, given i completes only high school

c_i = cost of attending college

y_i^f = family income of individual i

ec = economic conditions

dc = direct costs of college attendance

es = quality of elementary and secondary education

he = quality of higher education

Then assume that each high school graduate is faced with two options: to enter college, or to enter the labor force. The decision would be modeled in the following manner.

Let

$$Y_i^c = \sum_{t=1}^{4}\left(\frac{-c_{i,t}}{(1+r)^{t-1}}\right) + \sum_{t=5}^{T}\left(\frac{y_{i,t}^c}{(1+r)^{t-1}}\right) \qquad (1.2)$$

$$Y_i^h = \sum_{t=1}^{T}\left(\frac{y_{i,t}^h}{(1+r)^{t-1}}\right) \qquad (1.3)$$

[5] The income stream begins after the completion of college.

So that

Y_i^c = net present value of the lifetime income stream of individual i, given i attends college

Y_i^h = net present value of the lifetime income stream of individual i, given i enters the labor force immediately after completion of high school.

The individual faced with this decision is assumed to know the two incomes with certainty. Thus the individual will make the decision to attend college or not based on the above, available information. An individual will attend college if and only if the lifetime income stream of college attendance is greater than or equal to the lifetime income stream of completing only high school.[6] That is to say the probability that an individual attends college is

$$p_i = \begin{cases} 1 & if \quad Y_i^c - Y_i^h \geq 0 \\ 0 & if \quad Y_i^c - Y_i^h < 0 \end{cases} \tag{1.4}$$

Thus the individual faces the discrete choice of whether or not to attend college. This can also be modeled as a continuous variable. However, this study will use the discrete model.[7] Then the number of the eligible population (N) that attend college is simply,

$$P = \sum_{i=1}^{N} p_i \tag{1.5}$$

Therefore, P, the aggregate enrollment, is a function of the previously stated variables.

$$P = P\left(Y_i^c\left(y_i^c(he,ec), c_i\left(dc,es,ec,y_i^f\right)\right), Y_i^h\left(y_i^h(es,he,ec)\right), N\right) \tag{1.6}$$

then simplifying and writing (1.6) in reduced form, the number attending college becomes

$$P = P\left(y_i^f, ec, dc, es, he, N\right) \tag{1.7}$$

(+) (?) (-) (?) (?) (+)

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[6] At equality the individual is indifferent. Since education is beneficial to society, assume that the individual will choose to attend.

[7] $p_i = \Pr\left(Y_i^c - Y_i^h \geq 0\right)$, then the aggregation would be the same as above.

The hypothesized sign of the variable is listed below each variable. College is most likely a normal good, so that increases in income would be associated with increased enrollments.

The economic conditions are too broad to define a single effect. However, examining the previous example of the rate of unemployment may be of some interest. The unemployment rate will be a proxy for several determinants of the demand for higher education. First, it may act a measure of foregone opportunities. This would imply that the sign would be negative. Higher unemployment signals a greater portion of time in the labor force spent without a job, lowering the expected income from the high school degree. Second, it may serve as a measure of the availability of positions while in school. This would be the case if the student planned to work while going to college, or perhaps during breaks and vacations. Then the ability to finance higher education while in college will be more difficult with higher unemployment. If this latter effect dominates the former, then the unemployment rate would be negatively related to the probability of attending college.

The direct costs of attending college must be negatively related to college attendance. However, primary and secondary school quality has ambiguous effects on enrollment. The quality of elementary and secondary eductaion acts to increase the possible high school wage, thus negatively affecting enrollments. However, higher quality elementary and secondary education also increases the students chance of receiving a scholarship, thereby decreasing the direct cost of college attendance and increasing the likelihood of enrolling in college.

Holding tuition fixed, a higher college quality will increase enrollment. Graduating from a higher quality institution will tend to increase the student's income after college, thus having a positive relationship with enrollments. The final variable, the number of high school graduates, is expected to have a positive impact on enrollments. The more students that graduate from high school, the more students that are eligible to attend college.

Review of Literature

The body of literature dealing with the economic factors of the demand for higher education is rather large and diverse. While there are numerous approaches to modeling the demand for higher education, the majority of the economic studies use linear regression analysis. There is more variation in the type of data employed. Three data types can be characterized by the level of aggregation of enrollment and economic data: National data; State, regional or municipal data; and individual data. The review of the literature will first give a brief review of the findings from these studies, concentrating on stylized facts regarding income and price effects on college enrollment. Then a more detailed examination of the research in the above mentioned categories will be presented.

The various studies reviewed here all explained enrollment rates at institutions of higher education. The degree of aggregation, however, varies greatly. The micro level studies, such as Bishop (1977), Christiansen *et al.*, (1975), Borus and Carpenter (1984), Ghali (1977), and Savoca (1972) examined if the students were enrolled in college or not. Some of these studies used longitudinal surveys for their data. Savoca examined the decision to apply to an institution rather than the decision to enroll. Still others researched more aggregate trends in enrollment. Chressanthis (1986), Hoenack and Weiler (1979), Lehr and Newton (1978) and Strickland *et al.*, (1984), used a measure of the enrollments in a particular institution. They usually created a proportion by dividing the number of enrollees by some measure of the eligible population. Three of these studies examined freshmen enrollments specifically, Chressanthis, Lehr and Newton, and Strickland. Chressanthis extended his study to analyze head count and credit hours generated by each class, freshmen through senior. The final category of dependent variable used is the national aggregation of enrollments. Studies such as Campbell and Seigel (1967), Galper and Dunn (1969), Mattila (1982), Corazzini *et al.*, (1972) and Hight (1975) examined some measure of national enrollments. The first three

of these studies used undergraduate enrollment or a ratio of undergraduate enrollment. Two studies generated a ratio by dividing enrollment by the eligible population. Campbell and Seigel defined the eligible population as the number of 18 - 24 year olds who have a high school diploma and are not in the military. Mattila used the cohort population including members of the military. Galper and Dunn simply used the enrollment numbers as dependent variables.

Two explanatory variables are common to a majority of the studies. With few exceptions, some measure of cost was included. Most studies used direct educational costs (tuition, books, room-and-board, etc.) was included. Many studies also include some measure of the indirect costs of college attendance, such as foregone income while in school. Second, most studies incorporated a measure of family income.

The statistical method used in the empirical studies was generally Ordinary Least Squares (OLS) regression. The regression was of the form:

$$E = \alpha X + \beta Z + \delta W + \varepsilon \qquad (1.8)$$

where

E is the number or ratio of enrollment

X is the price of college education

Z is a measure of family income

W is a vector of other factors

This survey will concentrate on the magnitude, sign and significance of the coefficients α and β. These will be discussed first for the national studies, then for the subnational aggregate studies, and finally for the studies based on individual data.

The study of college education as an investment was carefully formalized in 1964 when Gary Becker published *Human Capital*. Becker set out to do a brief study of the monetary rate of return to college education in the U.S. It soon became clear that there had

not been much research that examined investment in people. Out of this lack of theory came Becker's model of human capital investment. One very significant contribution of this book is the development of the model under which investment in humans is examined. This investment takes many forms. On-the-job training, high school education and college education are the main forms of investment. Becker analyzed the effects of investment on earnings as well as rates of return. The theoretical model discussed previously is the portion of Becker's theory that is of interest to the current research.

Table 1.1 includes estimates of the price and income elasticities from the studies using national data. The first major empirical work using the human capital investment theory developed by Becker was conducted by Campbell & Seigel (1967). They estimated a simple demand function with the ratio of undergraduate degree seeking enrollment in 4-year institutions over the number of eligible 18-24 year olds as the dependent variable. The regression included two exogenous variables, costs of college and real disposable income per household. They used the log form for all of the variables. They found that enrollments are negatively related to price and positively related to income. The price elasticity was in the inelastic range at -0.44. The income elasticity was greater than one, implying that college education was considered a luxury good.

In the discussion of their model, they mentioned the problem of the indirect costs and non-monetary benefits of college attendance. They noted that the prospective student may place some monetary value on the nonmonetary costs and benefits of college attendance. The benefits of social, intellectual, and athletic activities that are available at most colleges add to the consumption value of the educational good. If individuals view education as a consumption good, then they can partially offset the costs of enrollment by the positive consumption benefits. The income effect was stronger than if education was merely an investment good. If current income and current consumption are normal goods, then an

increase in income will lead to an increase in enrollments for both investment and consumption reasons. However, the reduced form demand equation is still identical, so there is no empirical distinction between the consumption and investment views of the college enrollment decision.

Galper and Dunn (1969) estimated a model that is different from the basic model estimated by Campbell & Seigel. The main focus of their research was to find the effect of the armed forces on college enrollment. They estimated a linear model that included 5 lags of each variable. They included the following independent variables in their estimation equation: change in high school graduates, mean family income multiplied by the change in high school graduates, change in the size of the armed forces, the change in high school graduates, and the change in the number of discharges from the armed services. As theory would suggest, they found that changes in the armed forces are negatively related to enrollment. Thus, during the times of heavy military build up, college enrollment levels are expected to fall. They also found that income was positively related to enrollment with an elasticity less than one, and that the number of discharges from the armed services is positively related to enrollment as well.

Galper and Dunn also found that the effect of the lagged values decreased (in absolute value) as time continued. For example, the initial effect of income on enrollment is 0.44876. The second period effect was 0.24263. The fifth period effect was only 0.04788. Recall that they estimated the product of mean family income and the change in high school graduates. Their eligible population was determined by the sum of high school graduates in the current year, high school graduates in the preceding year, and the number of military personnel discharged in the preceding year. They assumed that the persons who joined the military did so with the expectation of completing college after their service.

Mattila (1982) also dealt with the effects of the military on college enrollment. He used aggregate time series data from 1956-1979 to determine, among other things, the effect that the military draft had on school enrollment. He found that the draft is positively related to college enrollment. Mattila also estimated the effect of the rate of return to college on college enrollment. He found that the rate of return is positively related to enrollment, as theory would suggest.

This is the only paper, in this review, that estimated the internal rate of return to education directly. Mattila calculated internal rates of return by equating the present value of the costs of college attendance (four years of college) and the present value of the benefits from college attendance, from age 23 to 61. Viewing his time series of rates of return to college education clearly showed a peak in 1968-69. The returns to education declined until 1978, one year before the end of Mattila's data set. A comparison with the relative salaries of college graduates to high school graduates indicates that the rate of return to college education probably increased in the early 1980s. Without directly calculating the internal rate of return, however, it is difficult to determine how the rate of return has changed in the late 1980s due the increases in both tuition and relative salaries.

Mattila's research showed that the decline in the internal rate of return to college education in the 1970s reduced enrollments by at least 18 percent. He also concluded that the magnitude of the effect of a change in the size of the armed forces is less than proportional. His estimates show that a 10 percent increase in the size of the armed forces reduced college enrollments by 1-2 percent. His findings on the effect of the draft are even smaller. A 10 percent increase in draft notices only increases enrollments by 0.6 percent.

One avenue of research that has received a great deal of attention is the distinction between public and private institutions of higher education. Corazzini, Dugan and Grabowski

(1972) and Hight (1975) are two studies that have included the cost of attending both public and private schools as independent variables in their analyses of the demand for education.

Corazzini, Dugan and Grabowski (1972) used national cross-sectional data from 1963 in their study. The dependent variable used was the percentage of 10th grade students (1960) in each state who were enrolled in college in 1963. They estimated four distinct price variables: tuition at a junior college, tuition at a public university, tuition at a teachers college, and tuition at a private college. They found that for all socioeconomic status (SES) groups combined the coefficient of each price is negative, ranging from -0.005 for teachers colleges to -0.027 to public universities.[8] They find that the enrollment response to private school tuition is -0.009 for all groups combined, but is positive, 0.007, for the lowest income group. For all the other groups, private tuition was a negative effect on enrollment. Public university tuition had a negative effect across socioeconomic levels.

Corazzini, Dugan and Grabowski also used the average hourly wage of production workers and the unemployment rate in their regression analysis. They found the coefficient on the wage rate to be negative and significant across all SES groups, except for the highest socioeconomic group. This was most likely showing the opportunity cost of attending college for the lower SES groups. The unemployment rate was positive for all groups combined and the two lower SES groups but negative for the two highest SES groups.

Hight (1975) estimated the effect of increases in costs at public and private institutions on enrollment levels at both public and private institutions. He included real disposable family income as one of the independent variables. He approximated the cost of attending college by using the difference between tuition and average financial aid per student at private and public schools. This measure was deflated by the consumer price index. He mentioned that the

[8]The coefficients are reported here. There was not enough information to generate the elasticity.

opportunity cost was correlated with family income and was therefore not included as a regressor.

The coefficients from Hight's regression of public school enrollments on the logarythms of the independent variables are as follows: public college costs, -1.783, private college costs 1.373, and family income 0.301. He also estimated the effects of these variables on private school enrollments and found these results: public costs 0.202, private costs -0.714, and family income 1.099. He concluded that the increase in private school enrollment can be attributed to the increase in family income. He also found that the decline in the number of undergraduate degree credit enrollment in private institutions relative to public schools can be attributed to the rise in the private relative to public costs.

Kim (1987) estimated a translog-linear expenditure system (LES) in his model of the demand for education. He used time series data from 1958-1982 to estimate the utility function. He took a different approach by embedding the college choice in a general model of consumption, using national consumption data to estimate the utility function. He included the expenditure share, lagged and current prices of durables, non-durables, private education and other services in the utility function. The elasticities were obtained by taking the partial derivatives of the utility function. The elasticities, at the means, are 1.33 for income, and -1.31 for the own price spending on education.

The studies that dealt with aggregate data at the state or local municipality level also included many of the same variables. They often took up the study of enrollment at a particular university or a limited number of universities. In most cases, the data correspond specifically to the region being tested. There is not a clear preponderance of time series or cross-sectional studies in the literature reviewed herein. The results of these studies are summarized in Table 1.2.

One study that analyzed time series and cross-sectional data is Lehr and Newton (1978). The time series results they found are briefly discussed here. They estimated equations explaining fall term freshman enrollment at: 2 year, 4 year, and private institutions in Oregon. The time series data spanned 1960-1974. Independent variables included: average annual real tuition, per capita income, unemployment rate, number in the armed forces, and high school graduates. They found results consistent with other studies: tuition elasticities of -0.6586 and income elasticities in the luxury range at 1.8822. In addition, they found the elasticity of unemployment to be 0.3309, an armed forces elasticity of 0.1485, and finally the elasticity of high school graduates at 1.0785.

Hoenack and Weiler (1979) estimated enrollment demand at the University of Minnesota and other institutions of higher education in Minnesota. Their interest was to develop a forecasting model for enrollments. They used a model with 10 equations: five equations estimated enrollment at various universities, and five estimated the economic variables that influence enrollments. The economic variables used in their research were college salaries, noncollege graduate salaries, and unemployment rates of various groups.

Hoenack and Weiler provided a rather extensive discussion of the effects of the economic variables on enrollment. First, they included three measures of unemployment. The first measure was the unemployment rate of 18-19 year olds. This should be negatively related to the opportunity cost of the time spent in college. The second unemployment rate was that of college graduates. This should be negatively related to the expected returns to college graduation. They also included the overall unemployment rate.

They listed three different explanations of the value of the time spent in college for noncollege graduates. The first was that the economic variables affect the future earnings if they do not attend college, thus the effects of wages and unemployment on enrollment are negative and positive, respectively. The second was that the economic variables influence the

value of the time spent in class and studying. Therefore, under this view, wages affect enrollment negatively and unemployment rates have a positive relationship with enrollment. The final view they mentioned was that the student may be expecting to be employed while in school as well as during the breaks and vacations. Thus wages and unemployment would have positive and negative effects on enrollment, respectively. They also explained that there is no a priori reason to believe that any effect will dominate.

The data revealed that a $100 increase in tuition at the University of Minnesota decreased enrollment by 1.15 percent. The coefficient of the natural log of the ratio of salaries was positive and ranged from 0.279 to 0.475. The exception is that the number of transfer students to the University of Minnesota declined when the salary ratio rose.

Strickland, Bonomo, McLaughlin, Montgomery and Mahan (1984) provided a similar study for the state of Virginia. They normalized the dependent variable, the ratio of new enrollees at particular institutions, as follows: the number of first-time students from a particular municipality enrolled at a particular institution was divided by the total number of new enrollees at that institution. This process was taken to allow various sized institutions to be grouped into three categories: major universities, old normal schools, and urban institutions.

They included independent variables which measure the educational attainment level and background for each municipality. The attainment variable was the number of persons in the area who have completed at least one year of college. The background variable was an average ability measure similar to an IQ score. They also included income, unemployment and price variables. For enrollments at all institutions, the elasticities were: -1.51 price, 0.023 wage, 0.48 unemployment, -0.45 municipal ability, and 2.36 municipal educational attainment. The price effect remained negative for all subsamples. The wage variable had a negative effect on enrollments for the major universities and urban institutions.

The final paper reviewed in this group of state aggregate studies analyzed the impact of tuition and economic changes on enrollments at a small state school in Michigan, Saginaw Valley State College (SVSC). In this paper, Chressanthis (1986) discussed five propositions of the elasticity measures.

- Price elasticity varies with class rank. Lower class rank (freshmen) shows greater elasticity. This confirms the notion of the behavior of students faced with continuation versus initial entrance into education.
- Price elasticity measures are affected by the availability of substitutes, increasing with the number of alternatives in close proximity to the student.
- Price elasticities increase as more time is allowed for price adjustment, i.e. the number of substitutes increase with increased search.
- Income elasticity varies according to the percentage of income used for college expenditures, with a large portion of income implying a greater income elasticity.
- Income elasticity will vary according to the cost of tuition, and also with the quality of the institution. The greatest income elasticities were found at higher quality, more costly schools.

The empirical findings follow the above propositions. The own price elasticity for freshmen is -1.74, while for seniors it is -0.589. Income was everywhere positive and thus education at SVSC is a normal good. These results suggest a multi-rate tuition system based on the class level of the student. Chressanthis justified the increase in tuition for more senior students by the decreased class size of more senior courses. The smaller the class, the lower the student/teacher ratio and the higher the cost to the institution.

The final group of studies reviewed here deals with individual choices of college attendance. These studies, because of the dichotomous nature of the attend/not attend decision, used a probit or logit model in the analysis. These findings are summarized in Table

1.3. Savoca (1990) was the only study reviewed here that dealt with the decision to apply to a college. Her study uses data from the National Longitudinal Survey of the high school class of 1972. This survey reported whether or not the high school student applied to college, and identified four groups of institutions to which the students applied. With the movement to individual data, new variables such as SAT scores, race and sex become available. She used these along with the costs of attendance as a portion of income, income alone, and a measure of school quality. The results of the study still support the negative relationship between price and college attendance, as well as the positive relationship between income and college attendance found in the majority of the other studies. The decision to apply was much more elastic, at -3.72 for tuition at four-year college and -2.26 for two year colleges, than the elasticities of the enrollment decision studied elsewhere.

Bishop (1977) used a logit model to estimate college attendance behavior of male high school juniors in 1960. The most significant result that is of interest to this study is that the price elasticity of all income levels and all abilities of students was -0.143. This again corresponds to the negative relationship between price and college entrance. Bishop measured the impact of family income on enrollment by stratifying the individuals across income and ability groups. He found that the response of a tuition increase from the highest income group was -0.084. The response of a tuition increase from the poverty income group was found to be -0.393, implying that lower income groups are more responsive to changes in the price of attending college. The same was found to be the case for the ability groups. The highest ability group had a tuition elasticity of -0.05. The lower-middle ability group's elasticity was -0.47.

Christiansen, Melder and Weisbrod (1975) used a probit model to estimate the impact of several variables on college attendance. They used individual data collected in 1963 with a follow up survey in 1967. The data was for students in Wisconsin, with the urban areas

of Madison and Milwaukee removed from the sample. They estimated factors such as individual class rank, IQ test scores, the type of university that is nearest the student, family income, the educational level of both the father and mother, and the father's profession. They found that the father's education level is the most highly correlated factor with college attendance. They also reported that females are strongly influenced by price and that males have smaller price elasticities than females. Another important factor for the female's decision to attend college was the mother's level of education. In females, this factor was more important than the father's educational level. They found that the income effect was relatively small. They stated that if income were almost tripled, from 7,000 to 20,000, the probability of attendance would only increase 9-10 percent.

Borus and Carpenter (1984) also used a probit model in their analysis. They used variables similar to Christiansen, et al (1975). Their data came from a survey of over 3 million 12th grade students in the spring of 1979. They noted that only 48% of those surveyed entered college. They analyzed the importance of the many factors in the decision to attend college. The most significant indicator of college attendance was the answer to the question, "Do you plan to attend college." Those that answered in the affirmative had a 68.7 percent mean rate of college attendance, those answering negatively, only 8.2 percent. The father's education level again was important. Those students whose father's attended college had a mean rate of college attendance of 72.6 percent. Other factors that they found to be important were the female's expectation about marriage. Females who did not plan to marry within five years after high school graduation were more likely to attend college.

When dealing with race factors they found that whites were more likely to attend than blacks or hispanics (48, 42 and 46 percent, respectively). However, these race factors were not found to be causal. They found these variables to be correlated with other variables of lower attendance rate groups, such as father's educational level and being two or more years

behind grade level. They inferred that improving minority schooling must begin by changing the other variables first. They also found that being enrolled in college preparatory courses increased the probability of attendance. However, there exists a selection problem with this result. They do not conclude that simply being enrolled in college preparatory courses will significantly increase the probability of attendance.

Finally, Ghali, Moheb, Miklius and Wada (1977) used a conditional logit model to estimate the probability of attendance of high school seniors in Hawaii (survey conducted in 1970). They found that the effects of an increase of 100 percent in the tuition at the University of Hawaii, Manoa or Hilo, led to only a 4.1 percent decrease in new freshmen enrollments for the state, implying an own price elasticity of -0.041. There appears to be a large increase in transfers to other colleges, such as community colleges. Another factor that is unique to Hawaii is the cost of travel to the west coast of the continental U.S. for a substitute university. It is at least 8 percent of the total cost of a west coast education.

The majority of the studies examined above revealed consistent results for the sign of price and income elasticities. The results of the price elasticity on enrollment are consistent with the law of demand. The results of the income elasticities indicate that education is a normal good. The current research will be examined in light of these studies. It is hoped that the results are found to be consistent with the stylized facts of the previous research.

Table 1.1 Summary of aggregate studies of national trends in the demand for higher education in the United States.

Study	Time Period	Method	Price Elasticity	Income Elasticity	Enrollment type used
Campbell & Siegel (1967)	1919-1964	linear regression	-0.44	1.20	all 4-yr. inst.
Galper & Dunn (1969)	1920-1965	distributed lag	N A	0.69	all inst.
Corazzini, Dugan & Grabowski (1972)	1963 cross-sectional	linear regression	-2.65[a]	N A	freshmen
Hight (1975)	1927-1972	linear regression	-1.78[b]	0.30	all inst.
Mattila (1982)	1956-1979	linear regression	0.88[c]	0.99	all inst. (males)
Kim (1987)	1958-1982	translog-LES	-1.31[d]	1.33	N A

a Enrollment response of a $100 increase in 1963 tuition.
b Estimate of Public School Tuition
c Estimates Rate of Return to College Education
d Estimate of Private Tuition

Table 1.2 Summary of results of studies using aggregate data on individual states or schools.

Study	Time Period	Method	Price Elasticity	Income Elasticity	Enrollment type used
Lehr & Newton (1987)	1960-1974 Oregon	linear regression	-0.66	1.88	freshmen
Chressanthis (1986)	1964-1983 SVSC[a]	linear regression	-1.74[b]	1.39[c]	each class individually
Strickland, et al (1984)	1980 Virginia	generalized linear model	-1.51	.023	freshmen
Hoenack & Weiler (1979)	1977 Minnesota	linear regression	-1.15[d]	N A	freshmen

a Saginaw Valley State College, a small Michigan State College
b Freshmen enrollment
c Freshmen enrollment
d Change in initial enrollments per $100 increase in tuition.

Table 1.3 Summary of research on individual demand for higher education.

Study	Time Period	Method	Price Elasticity	Income Elasticity	Enrollment type used
Bishop (1977)	1960	binomial logit	-0.143	N A	freshmen
Savoca (1990)	1972 NLS[a]	linear regression	-0.147	0.24	freshmen
Ghali *et al.* (1977)	1970 Hawaii	conditional logit	-0.041[b]	N A	freshmen

a National Longitudinal Survey of the High School Class of 1972
b With respect to tuition at University of Hawaii, note that travel costs alone, to the West Coast are 8% of the total cost of education at west coast cities. Total cost estimate there are -.048.

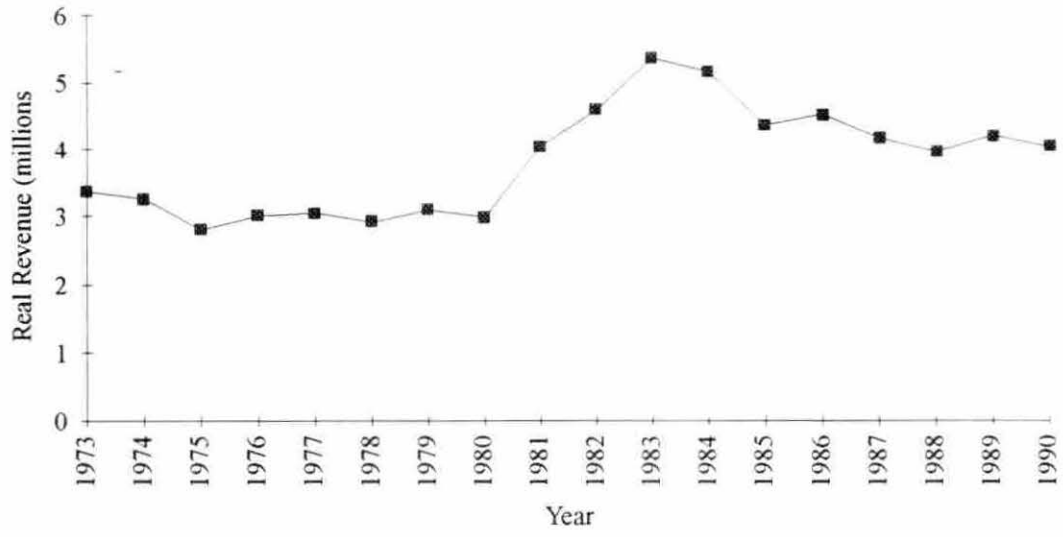

Figure 1.1 Real nonresident tuition revenues at Iowa State University, 1973- 1990.
Source: *Iowa State University Enrollment Services Annual Statistical Report.*

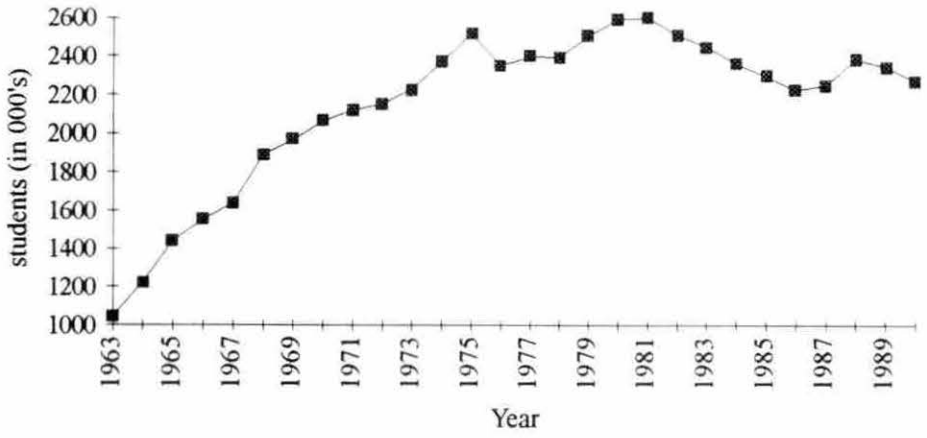

Figure 1.2 First-time students in all institutions, 1963 - 1990.
Source: *Digest of Educational Statistics.*

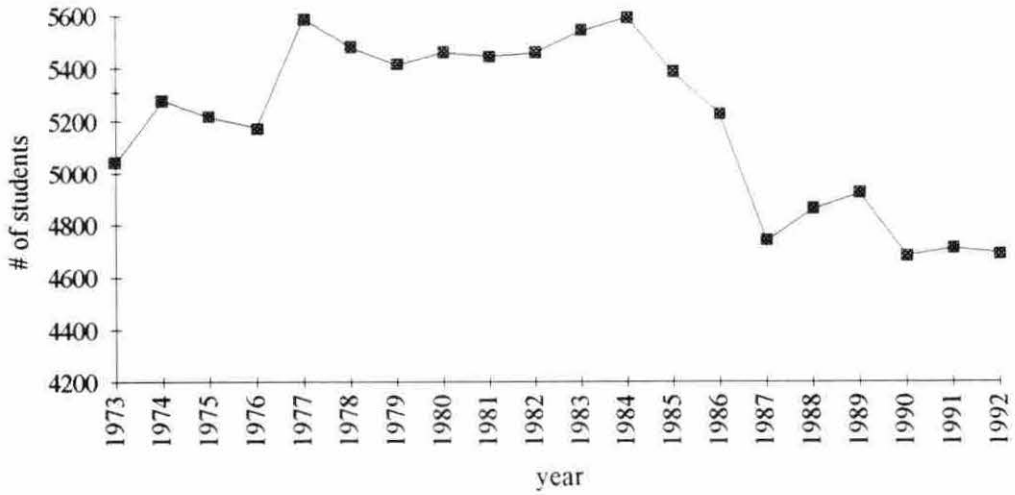

Figure 1.3 New fall enrollees at Iowa State University, 1973 - 1992.
Source: *Iowa State University Enrollment Services Annual Statistical Report.*

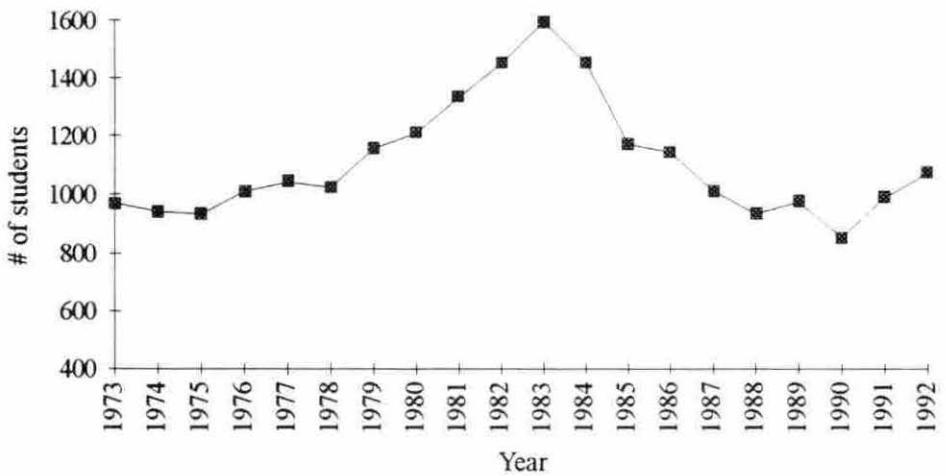

Figure 1.4 Nonresident enrollment at Iowa State University, 1973 - 1992.
Source: *Iowa State University Enrollment Services Annual Statistical Report.*

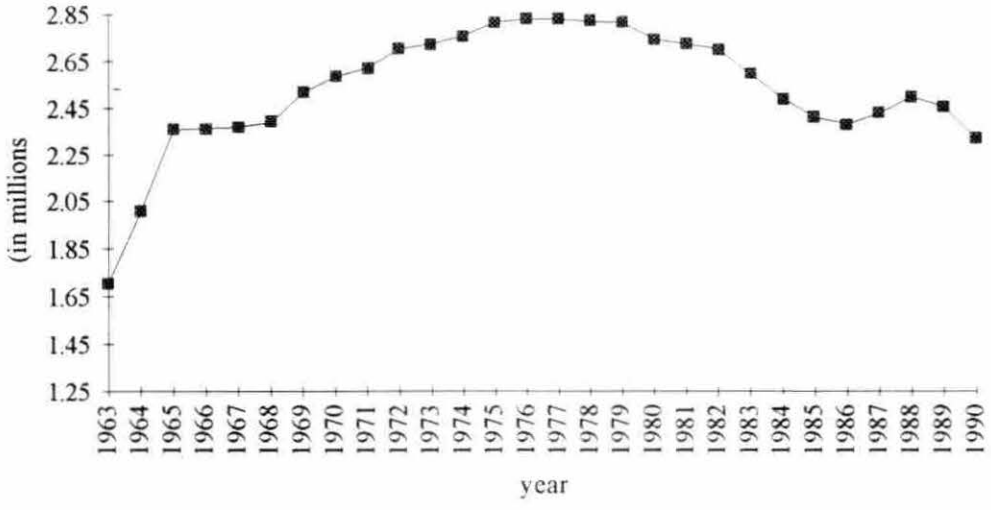

Figure 1.5 The number of U.S. high school graduates, 1963 - 1990.
Source: *Digest of Educational Statistics.*

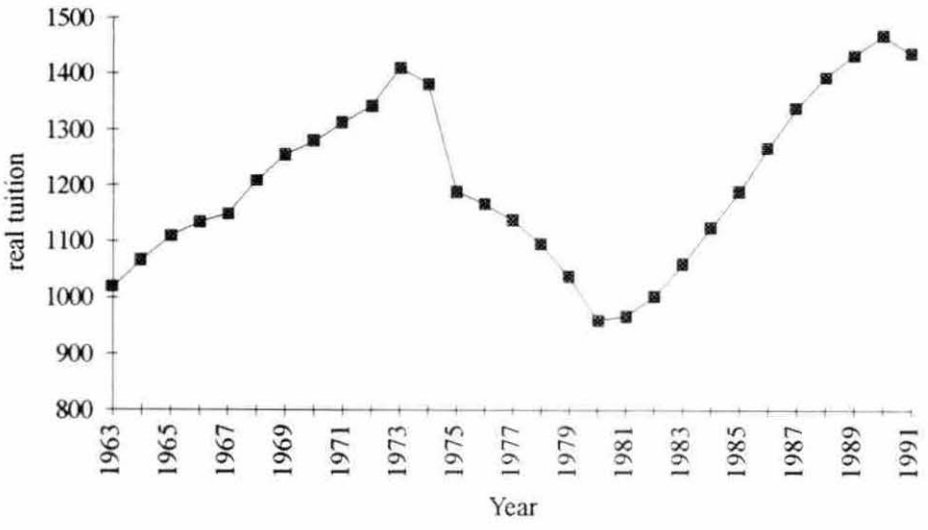

Figure 1.6 Average real in-state tuition, 1963 - 1992, (1987 dollars).
Source: *Digest of Educational Statistics.*

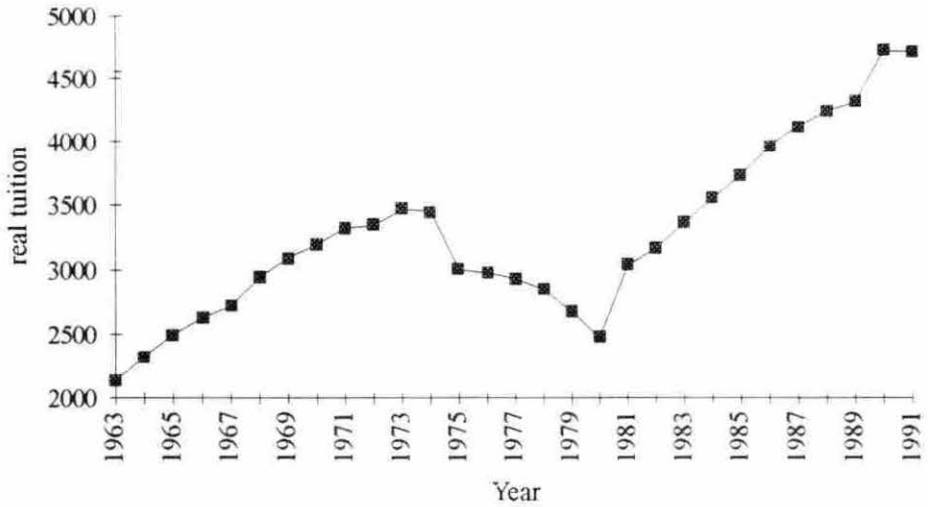

Figure 1.7 Average real nonresident tuition, 1963 - 1992 (1987 dollars).
Source: *Digest of Educational Statistics.*

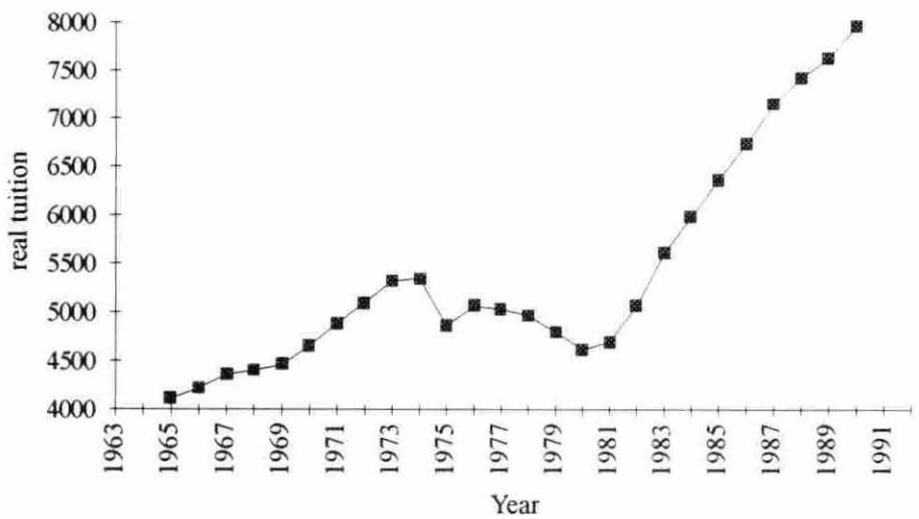

Figure 1.8 Average real private tuition, 1963-1990 (1987 dollars).
Source: *Digest of Educational Statistics.*

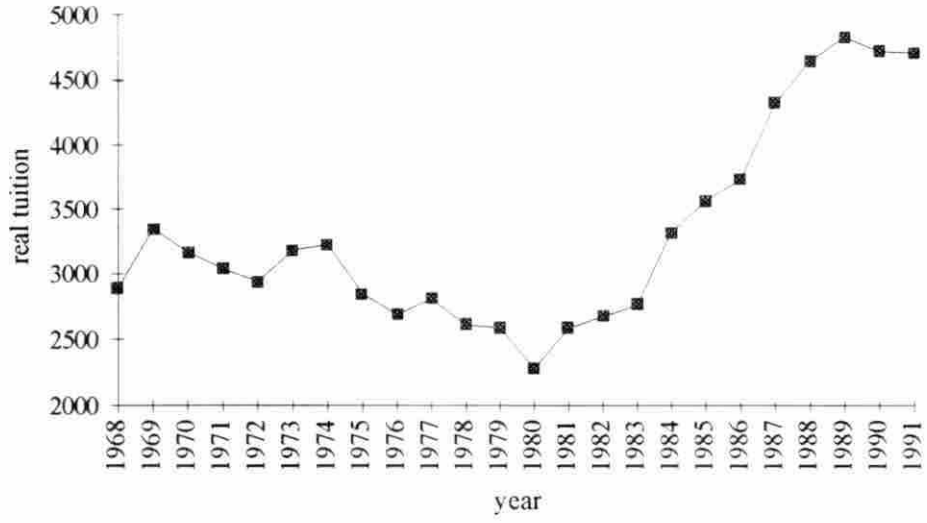

Figure 1.9 Real nonresident tuition at Iowa State University, 1968 - 1991 (1987 dollars).
Sources: *Digest of Educational Statistics, Iowa State University Enrollment Services Annual Statistical Report.*

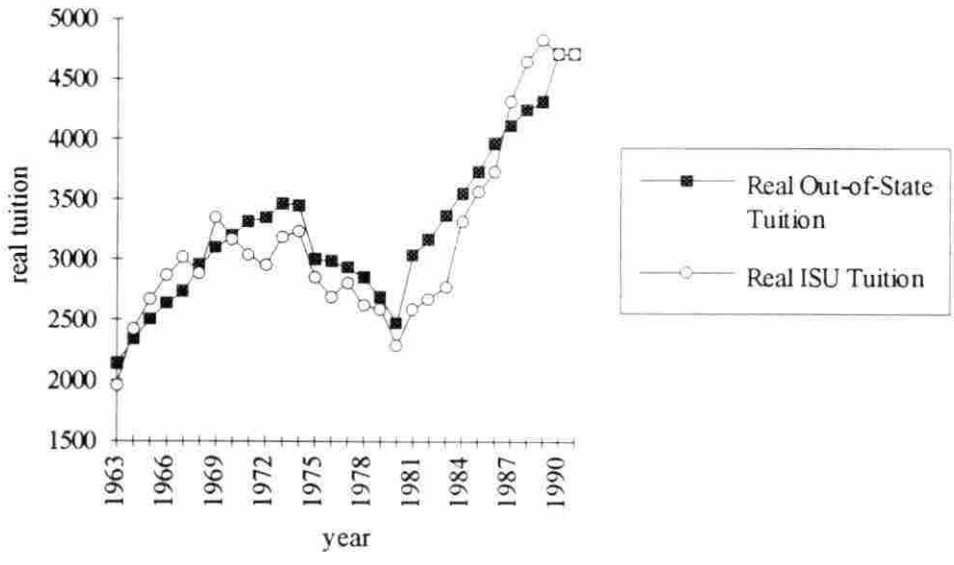

Figure 1.10 National Average and Iowa State real nonresident tuition 1963 - 1991 (1987 dollars).
Sources: *Digest of Educational Statistics, Iowa State University Enrollment Services Annual Statistical Report.*

CHAPTER 2

DEMAND FOR HIGHER EDUCATION BY STATE AT THE NATIONAL LEVEL

The factors that influence the demand for higher education, as previously stated, are important for policy makers at many levels. The Clinton administration is proposing a new program at the national level to make college education available to more people. This program will allow college students to borrow funds necessary for completing college. Then, rather than cash repayment of the loan, the student will have the option to repay a portion of the loan by performing some type of community service. In 1992, there was a bipartisan proposal to implement a tax break for families with children in college.[1] These are only a few of the many programs that are aimed at making the opportunity of college education available to more students. This chapter empirically explores the question of which factors influence the decision to attend college. It is relevant to the aforementioned programs in the sense that policy makers will be able to determine what type of assistance program yield the largest net benefit. For example, if price is an important factor then an effective program would address methods of decreasing tuition and other costs incurred while attending college. However, if family income is shown to be an important factor in college attendance, then the program might need to increase the income of families with college age children, perhaps through tax policies.

Overview of Data Used in Empirical Analysis

The theoretical model discussed previously allows the examination of the demand for higher education at the state level by using the model to measure the factors that influence the decision to attend college at an aggregated level. This will involve analysis of college enrollment levels by state. The factors that influence the number of students enrolling will

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[1]This was proposed by Senators Charles Grassley and David Boren. An editorial by Senator Grassley appears in the Christian Science Monitor, March 3, 1992, p 18.

also be aggregated to the state level. Measures for the aggregate factors of the variables mentioned in the theoretical model will often be state wide averages.

This research will use ordinary least squares regression (OLS) as the primary method of analysis. Two dependent variables will be examined. The first is the aggregate number of students attending all post-secondary institutions in a given state and year. The second is the aggregate number of students attending public institutions. The theoretical model will appear as follows for this analysis.

$$fts_{s,t} = \beta_0 + X_{s,t}\beta + e_{s,t} \qquad (2.1)$$

where

$fts_{s,t}$ is the number of first-time students enrolled in state, s and year, t (in all institutions or in only public institutions as noted)

$X_{s,t}$ is the vector of independent factors that influence the decision to attend college in state, s and year, t.

β_0 is a constant term

β is a vector of coefficients corresponding to the vector of factors X

$e_{s,t}$ is an error term for each state in each year

The vector of factors, X, includes the following variables: in-state tuition, out-of-state tuition in the surrounding states, private tuition, per capita income, the number of high school graduates, relative salary of college and high school graduates, public school expenditures per pupil, spending on higher education, the unemployment rate, a dummy variable for the years of the draft deferment, and a dummy variable for a change in the measurement of the dependent variable.

There are some measures mentioned in the theoretical discussion that do not appear in the empirical analysis. In most cases, this is due to the data not being available in suitable format. The best example and perhaps the most important variable not included in the

empirical analysis is a measure of the financial aid that is available to students attending college. This is most likely to be some type of scholarship based on merit or need. It may also be important to consider subsidized grants and loans as well. All three of these act to decrease the cost of attending college. Although this data is available at the federal level, the goal of this research is to account for state by state variations in college attendance. Since state level financial aid was not published for any significant length of time this measure was left out of the empirical model.

This chapter will examine the enrollment trends from 1966 to 1987. The factors that influence the decision to attend college at the national level will be examined in this chapter. The data is thus arranged by state, with each state having equal weight in the analysis.

Discussion of Variables

The data used in this portion of the research is listed below. The source and any correction method are listed also. The definitions are summarized in Table 2.1.

This project utilized data observations for each state in the continental United States. Data for Alaska, Hawaii, and Washington, D.C., was omitted. Data was gathered and recorded in current (nominal) dollars and changed to constant (1987) dollars by dividing by the Consumer Price Index (CPI). The time period used for this report is 1966 to 1987. The following are the list of variables used and their sources.

Variable Definitions

*First-Time Students in All Institutions: The number of first-time students enrolling in all institutions. Two sources were used for this data. The first source, *Fall Enrollment in Colleges and Universities*[2], was reported for the years 1966-1969, 1971-1980, 1982, 1983. A similar measure was published in *State Higher Education Profiles*. This measure is

[2]The title of this serial was changed to *Fall Enrollment in Higher Education*.

reported for the years 1984 - 1987. Both of these measures were published by the National Center for Educational Statistics.

*First-Time Students in Public Institutions: The number of first-time students enrolling in publicly controlled institutions. Two sources were used for this data. The first source, *Fall Enrollment in Colleges and Universities*, was reported for the years 1966-1969, 1971-1975 and 1980.[3] A similar measure was published in *State Higher Education Profiles* for 1984- 1987. Both of these measures were published by the National Center for Educational Statistics.

*College Salary: National mean annual salary of all males 25 and over, who have completed four or more years of college. Published in the *Current Population Survey*.

*High School Salary: National mean annual salary of all males 25 and over, who have completed 4 years of high school. Published in the *Current Population Survey*.

*National Relative Annual Salary: The ratio of college annual salary over high school salary.

*Higher Education Expenditures: The current fund expenditures of public institutions of higher education. This was reported in the *Digest of Educational Statistics*, published by the United States Department of Education, National Center of Educational Statistics..

*Local Subsidy: Higher education expenditures divided by the sum of the four previous years of high school graduates. This was used as a measure of quality and state support of higher education.

*High School Graduates: The number of public high school graduates in each state as reported in the *Digest of Educational Statistics*, by the United States Department of Education, National Center for Educational Statistics.

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[3]The breakdown of the state data for public institutions was not published in this source after 1975. Although the tables were said to be available, a library search and phone contact with NCES yielded data for 1980 only. Special thanks to Dr. Vance Grant at NCES, for the 1980 data.

*Own State Resident and Nonresident Tuition: A measure of tuition and fees for residents and nonresidents at public universities in the state. Three different sources were used to obtain tuition data. The *Digest of Educational Statistics*, complied by the United States Department of Education, National Center for Educational Statistics, provides state average tuition and fees at public 4-year universities. This is the most reliable data and was used whenever available (1981, 1983, 1986, 1989, and 1991). Tuition and fees were also taken from *Barron's Profiles of American Colleges* and *The College Blue Book*. These two sources listed data for individual schools rather than a state average. The 4-year public university with the largest enrollment was used from each source. The institutions are listed in Table 2.2. *Barron's* was used when available (1963, 1967, 1971, 1973 and 1981). *The College Blue Book* was used to fill in the years when *Barron's* was not available (1978 and 1980). Linear interpolation was used when there was no data for a given year.

Using two measures of college tuition and fees poses a problem of comparability. Since the *Digest of Educational Statistics* reported state averages and the other two sources used individual colleges the two observations are not comparable. To remove this problem the following weighting method was used.

Let

D_{ti} = *Digest Of Educational Statistics* observation for the average 4-year tuition and fees for the t^{th} time period and the i^{th} state.

B_{ti} = *Barron's Profile of American Colleges* observation of the largest school's tuition and fees for the t^{th} time period and the i^{th} state.

T_{ti} = The observation used in the regression analysis for the t^{th} time period and the i^{th} state.

Then

$$T_{it} = \begin{cases} \frac{D_{81t}}{B_{81t}} B_{it} & for \quad t < 1981 \\ D_{it} & for \quad t \geq 1981 \end{cases} \qquad (2.2)$$

This translates all observations into units consistent with the *Digest of Educational Statistics*.

*Out-of-State Tuition in Adjoining States: The average of nonresident tuition and fees (as calculated above) in all states sharing a border with the state.

*Own State Room-and-Board: The annual cost of room-and-board at 4-year public universities. The sources and data adjustment method are the same as that used for calculating own state tuition.

*Private Tuition: National average undergraduate tuition and fees at private institutions of higher education. Reported in the *Digest of Educational Statistics* by the United States Department of Education, National Center for Educational Statistics.

*Private Room-and-Board: National average annual undergraduate room-and-board at private institutions of higher education. Reported in the *Digest of Educational Statistics* by the United States Department of Education, National Center for Educational Statistics.

*Public School Expenditure: The current fund expenditure per pupil in average daily attendance in public elementary and secondary schools was used as a quality measure specific to each state. Reported by the U.S. Department of Education, National Center for Education Statistics in the *Digest of Educational Statistics*.

*Consumer Price Index (1987): Reported by the Department of Labor, Bureau of Labor Statistics in the *Statistical Abstract*.

Per capita Income: The state personal income per capita in current dollars. It is published by the U.S. Bureau of Economic Analysis, Survey of Current Business in the *Statistical Abstract*.

*Unemployment rate: Unemployment rate of all civilian workers, aged 18-19. Reported in the *Handbook of Labor Statistics* by the Bureau of Labor Statistics, United States Department of Labor.

*Dummy Variables

*Data: A dummy variable to control for the two different sources of first-time students. Examination of the data made it clear that the numbers in the two series were not consistent.

$$\text{data} = \begin{cases} 1 & \text{for year} = 1984 - 1987 \\ 0 & \text{for year} = 1966 - 1983 \end{cases} \tag{2.3}$$

*Draft: A dummy variable to control for the draft deferment program.

$$\text{draft} = \begin{cases} 1 & \text{for year} = 1966 - 1971 \\ 0 & \text{for year} = 1972 - 1987 \end{cases} \tag{2.4}$$

Variable Characteristics

This section will give statistical information and characteristics of the above variables. Due to the log form being used in the analysis, both the mean and standard deviations for the level as well as log form are given in Table 2.3. A brief discussion of the time trends of the variables and their hypothesized impact on enrollment levels in the analysis follows.

This analysis only uses the first-time students. Chressanthis (1986) showed that freshmen had the highest price elasticity of all four college levels. This is to be expected since switching colleges can be very expensive in terms of lost credits and search costs, relative to the cost of choosing a college for the first time. In addition, studies of earnings indicate little return from attending one or two years of college, so dropping out is also expensive. The number of first-time students enrolling in higher education has fluctuated over the period of analysis, which runs from 1966 to 1987. The time trend of total enrollment was shown in Figure 1.1. Note, however, that this is not the time trend of the variable used in the current

empirical analysis. Due to the lack of availability of a single consistent series of state-level data, two different sources had to be used. Figure 2.1 shows the time trend of the national level data reported in Figure 1.1 along with the sum of the data used in this analysis across the fifty states. The time series clearly shows the need for the dummy variable, called "data", mentioned previously. There is a clear break at 1984, the beginning of the second data source. It also shows that the time paths of the summed state enrollments and the reported national enrollments are very similar and that the data used in the analysis is a reasonable proxy for national enrollment levels.

The time paths of resident and nonresident tuition are shown in Figures 1.5 and 1.6, respectively. The cost of attending a school outside the student's home or own state is measured here by the average of nonresident tuition for all adjoining states, with each state receiving equal weight. Although both resident and nonresident tuition increased in real terms, the rate of increase for nonresident tuition is far above that for resident tuition. This would presumably act as a deterrent for students considering leaving their own state to attend college in an another state. However, since this analysis deals with aggregate state enrollment and does not differentiate between a resident student and a nonresident student, it is not clear how this rapid increase of nonresident tuition will influence the state enrollment mix of residents and nonresidents. The other option faced by the student would be to attend a private institution. Thus, private tuition is included as an independent variable.

The analysis also uses the sum of tuition and room-and-board as regressors. This might be considered a more accurate measure of the total cost of attending college. This measure of costs for resident students is expected to have a negative relationship with enrollment, as well. Nonresident costs are expected to be positively related to enrollment in the own state. If the cost of attending an institution in a neighboring state increases, it is

expected to have a positive impact on the enrollment in the state. The above two hypothesized effects are the same for both of the dependent variables.

The cost of private education has seen the largest real increase of the three institutional groups examined here. The price of private education, private tuition or private costs, is expected to have different impacts depending on the dependent variable used. The price of private education is expected to have a negative effect on enrollment in all institutions, but a positive effect on the enrollment of publicly controlled institutions. The latter effect would follow the reasoning that if the price of private education increased, there would be a number of people that would choose to attend a publicly controlled institution instead of attending a private institution.

The sign of the income coefficient will indicate if education is perceived as a "normal" or "inferior" good. A positive sign implies that education is a normal good. This would be the expected sign, as indicated in previous research on the topic. If the coefficient of income is negative then education would be considered an inferior good, and the participation rate would decrease with an increase in income. If income is positively related to enrollment levels, increasing income of families with college-aged students would tend to increase the number of students enrolling in higher education. However, the mix of public versus private education may change as income increases. As per capita incomes rise, enrollment may shift toward private or out-of-state schools.

The theoretical model calls for some measure of the quality of elementary and secondary schools. A proxy for this is the elementary and secondary expenditures per pupil. The rationale behind this proxy is that with more funding per pupil, the school is able to invest more in the child's education. Relative advantages in educational technology available to students, better student teacher ratios, and other superior inputs available in these states should improve the quality of education that students receive. Of course, one can argue that

some of the funding increases will not have positive benefits for the students. For example, Hanushek (1986) found that expenditures per pupil had strong simple correlation with achievement. However, when family background and other differences are accounted for, the correlation between expenditures and achievement was not found. Nevertheless, no other consistent measure of state school quality is readily available. To the extent that the hypothesized relationship holds, students who attend schools with more funding will be better prepared for college, and have a higher probability of success while in college. In addition, states with relatively high levels of per capita school expenditures may simply be states with strong tastes for education. In either case, states with higher school expenditures should have higher propensities to enroll in college. The increased quality of elementary and secondary schooling will also tend to increase the income of the high school graduate, thereby decreasing the likelihood of college enrollment.

Similar logic underlies the measure for the quality of higher education. This study uses the amount of public funding for higher education as a proxy for quality. To make this measure comparable across various sizes of states, total spending is divided by the number of high school graduates for the preceding four years. This gives a proxy measure for per student spending on higher education, in each state. The assumption is that more funding will enhance the students' learning and thus have a positive impact on future earnings.

Another factor that is expected to affect the decision to enroll in college from the theoretical model is the expected increase in income from completing college. To measure this, the ratio of college graduate salaries over high school graduate salaries was used. This is referred to as the returns to college education. It represents the expected monetary returns from attending college. These returns to college education have seen significant increases in the past 20 years. Figure 2.2 presents the time path of the ratio of college salaries to high school salaries. In 1974, there was a 35 year low in the ratio, with college salaries falling to

less than 50 percent above the high school salary level. Since then, the returns to college education increased. By 1986, the level was nearly 80 percent above the high school salary. The 1991 ratio is even higher than the ratio in 1986. The ratio of college to high school salaries throughout the late 1980s was nearly 25 percentage points higher than in the 1970s. This would be expected to increase the number of students enrolling in college. The degree of the impact will be determined in the regression results that follow.

Discussion of Empirical Model

The empirical model uses the estimation technique of ordinary least squares (OLS). The natural logarithm form of the variables is used in the analysis. This will make the coefficients of the independent variables interpretable as elasticities. Elasticities give the percentage change in enrollment from a one percent change in the independent variable. The natural logarithm of the number of first-time students is regressed on the following independent variables in log form: in-state (resident) tuition, out-of-state (nonresident) tuition in adjoining states, the national average private tuition, per capita income, relative college salaries, the number of high school graduates, per pupil spending in elementary and secondary schools, per capita expenditures on public institutions of higher education, the unemployment rate, a dummy variable for the draft deferment program, and a dummy variable for changes in the data series. Another price measure, the total cost of attending school, is tested by adding the measure of room-and-board at public and private institutions to the tuition measures.

A problem that appears in the empirical analysis is that the error terms may be correlated across time. The extent to which this is a problem is measured by the Durbin Watson test statistic. This is shown to be a problem, so a correction is made. This involves regressing the dependent variable on the independent variables, the lagged value of the dependent variable, and the lagged values of the independent variables simultaneously. This

method was developed by Cochrane and Orcutt. A brief explanation of the process follows. Suppose that the initial OLS equation is of the form in (2.5).

$$y_t = X_t\beta + \varepsilon_t \tag{2.5}$$

Under autocorrelation the error term is characterized as being the sum of the lagged value of the error times a constant and an uncorrelated error term. The error term would be of the form in (2.6)

$$\varepsilon_t = \rho\varepsilon_{t-1} + \eta_t. \tag{2.6}$$

Note also that

$$\varepsilon_{t-1} = y_{t-1} - X_{t-1}\beta. \tag{2.7}$$

By substituting (2.6) and (2.7) into the error term in (2.5) and simplifying, the corrected model can be derived as (2.8),

$$y_t = X_t\beta + \rho(y_{t-1} - X_{t-1}\beta) + \eta_t$$

or

$$y_t = X_t\beta + \rho y_{t-1} - X_{t-1}\phi + \eta_t \tag{2.8}$$

with the constraint that

$$\phi = -\rho\beta. \tag{2.9}$$

The equation to be estimated under the constraint is

$$y_t = (X_t - \rho X_{t-1})\beta + \rho y_{t-1} + \eta_t. \tag{2.10}$$

This is the Cochrane-Orcutt correction for autocorrelation if the model is estimated using maximum likelihood.[4] Alternatively, one could estimate (2.8) to obtain a first stage estimate of ρ. Then in the second stage, one would estimate the equation

$$(y_t - \hat{\rho}y_{t-1}) = (X_t - \hat{\rho}X_{t-1})\beta + \eta_t. \tag{2.11}$$

Discussion of Empirical Results

The initial analysis was completed using ordinary least squares. Four specifications of the model were used. Two dependent variables were analyzed under the two sets of

[4]Sources: Fromby, Hill and Johnson (1984), Greene (1990) and Johnston (1984).

independent variables. The results are given in Tables 2.4 and 2.5. Table 2.4 gives the results of a model using the tuition measures alone. Table 2.5 gives the results for the measures of total cost (the sum of tuition and room-and-board) with the other independent variables being the same. Each table has four model specifications. The first specification has the dependent variable of first-time students in all institutions with all three price variables. The second column has the same dependent variable but does not include the price of private institutions. The next two columns have the same independent variables as the first two, but the dependent variable consists only of enrollment in publicly controlled institutions.

OLS results

The first specification of the model shows some very important results. As the theory suggests, the coefficient on resident tuition is negative. It ranges from -0.158 to -0.275. Note that it is also significantly different from zero at the 1 percent level. Since this coefficient can be interpreted as an elasticity, the impact of an increase in tuition on enrollments can be determined immediately. The results suggest that a 1 percent increase in resident tuition will lead to a minimum of a 0.15 percent decrease in resident enrollments, *ceteris paribus*.

The model that uses total costs gives similar results. Table 2.5 gives the results of these specifications. The signs of the resident costs are negative and significant at the 1 percent level with the exception of the first specification which is significant at the 10 percent level. These results indicate that if total costs increased by 1 percent, enrollment will decrease by about 0.1 percent.

The results of the elasticity of tuition indicate that additional revenue is possible from increases in tuition or costs if they can be coordinated across all institutions in the state. Collusive arrangements to raise tuition in common across states would sharply raise revenue, given the highly inelastic demand for own state institutions. The recent court case in which Ivy league institutions were found guilty of more than 30 years of collusive price fixing seems

consistent with this finding that such collusive arrangements would be highly profitable.[5] This implies that a profit maximizing institution could increase resident tuition rates and increase the revenues from tuition. However, most of the public institutions do not have profit maximization as a main goal. Recalling the federal legislation to increase the availability of college education to all students, any type of increase in tuition or costs would decrease enrollments and be counterproductive with respect to the legislation. This is due to increases in tuition or costs causing decreases in enrollment, although relatively small. Presumably, the students who decide not to enroll as a result of a tuition increase would have been on the margin of attending college or going to the work force. They were able to afford college prior to the tuition increase. However, after an increase in tuition, college is no longer affordable. This would be a direct contradiction to the current plan of making college more available to all people.

The results are similar when only public school enrollments are examined. This result shows that the reduction in enrollment would be more significant among public institutions. The results indicate that a 1 percent increase in tuition would lead to a 0.25 percent reduction in the number of students enrolling at public institutions. The coefficient of the total cost of college is higher still, as is shown in Table 2.5. The results indicate that a 1 percent increase in total costs at public institutions will decrease public school enrollments by almost one half of one percent.

There are at least two possible explanations for the increase in the price elasticity when only public school enrollments are considered. The first is that the prospective students who are very concerned about costs will not consider the higher priced private institutions. These students will be more sensitive to the price of enrolling. They may be more apt to choose not to enroll in college and enter the labor force than those considering both public and private

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[5]Source: Time (September, 14, 1992. p 25). MIT is reported to be the only school appealing the decision.

education. The second reason the price elasticity might be higher is that as the price of public education increases, the relative cost of attending an in-state private institution falls. Some of the reduction in state public enrollment results in an increase in state private school enrollment, and so the net change in state college enrollment is smaller than the change in public enrollment. This reduction in measured price sensitivity at more aggregated levels of demand is a common result in studies of demand.

The price of institutions outside the student's own state does not yield consistent results across the four specifications listed in Table 2.4. In the first two columns, in which all enrollments are considered, the coefficient has the hypothesized sign. They are also significant at the 1 percent level. These coefficients show that an increase in the nonresident tuition in surrounding states will increase enrollment in that state, although the effect is less than proportional. The last two columns of Table 2.4 indicate that nonresident tuition in adjoining states is negatively related to enrollment levels in that state. Notice, however, that these coefficients are not statistically different from zero. Table 2.5 gives similar results regarding the signs of the total cost for nonresidents attending college in an adjoining state. The cost measure is positively related to total own state enrollments, however, in this specification this coefficient is not significantly different from zero. In addition, enrollments in publicly controlled institutions are negatively related to the price of nonresident tuition in adjoining states. The results for public enrollments are not consistent with theoretical expectations, and there is not a clear explanation as to why this occurs.

The coefficient of private tuition is expected to switch signs with the two dependent variables. Theory suggests that private tuition (or costs) will be negatively related to enrollments in all institutions, but positively related to enrollments at publicly controlled institutions. The measure for private tuition does follow the theoretical expectations. The sign is negative with all enrollments and positive with public enrollments. When the measure

of total costs are considered the results do not hold. The signs are negative for both dependent variables, albeit insignificant in the public enrollment case.

The income elasticity, shown here as the coefficient of the income variable, is positive across all specifications. However, it is only significantly different from zero for the specifications which consider total costs instead of tuition. The latter results, shown in Table 2.5, indicate that family income would need to increase by nearly 4 percent to increase enrollments by 1 percent.

It seems that the variable with the largest single consistent impact on enrollment is the number of high school graduates from that state. The sign of the coefficient is positive and significant in all specifications. The models that consider enrollment in all institutions have coefficients that range from 0.914 to 0.931. This indicates that for every one percent increase in the number of high school graduates, there is between a 0.9 and 1.0 percent increase in enrollment in higher education. This does not imply that every student graduating from high school attends college. Rather, as the number of high school graduates increases, an increase of near equal proportion can be expected in college enrollment. The coefficient of high school graduates for the model that consider only public institutions is slightly smaller, 0.83 to 0.86, but is still significant at the 1 percent level.

It appears that the measure for increased returns to college does not support theory. The sign is expected to be positive, showing that an increase in the salary of college graduates relative to high school graduates increases the incentive to attend college. However, the empirical analysis indicates the opposite. The signs are all negative and the coefficients are significant in some cases. These results indicate that increased returns to college education act as a disincentive to attend college. However, this does not seem reasonable and indeed is counter to what theory suggests.

The effect of unemployment on enrollment is found to be positive. This supports the theory that the unemployment rate is inversely related to the opportunity cost of attending college, and therefore is positively related to enrollment. Higher unemployment rates would imply less of a chance to obtain work, and therefore the cost of college attendance is decreased. It is counter to the argument that the unemployment rate is a measure of the income while in college, which would imply a negative relationship with enrollment. These theories were discussed in detail by Hoenack and Weiler (1979), and briefly mentioned in Chapter 1. The coefficients are positive and significant at the 1 percent level in all the specifications except the models that regress the total cost measures on public enrollments. The coefficients range between 0.2 to 0.27. The interpretation of this coefficient is that if the unemployment rate increases by one percent, enrollment will increase by 0.2 to 0.27 percent.

The two measures of school quality show the positive signs. The coefficient for spending at the elementary/secondary level ranges from 0.176 to 0.389 and is significant at the 1 percent level across all specifications. This implies that there are positive benefits from increasing spending on the pre-college students, assuming that college attendance is a goal in itself. Increasing spending at the college level is also positively related to enrollment levels. This has at least two interpretations. The increased higher education expenditures may be increasing the expected benefits of students after graduation. They may perceive a positive relationship between the quality of the school they attend and their salary after graduating. It might also imply that the students have a larger expected subsidy for attending institutions in the state, holding tuition fixed, and are more likely to attend.

The statistical properties of the model as a whole are rather good. Approximately 92 percent of the variation in enrollments is explained by the independent variables, implied by the R-squared statistic. However, as discussed previously, the Durban-Watson statistic

indicates that there is a problem with correlation of the variables over time.[6] The test statistic is well below the lower bound critical value of 1.561.[7] Notice also that the value is below 2, implying positive autocorrelation in the residuals.[8] A likely cause of this correlation is interpolation of the independent variables. Particularly, the variables of resident and nonresident tuition were interpolated over several years. If this interpolation is the cause of the autocorrelation, deleting the interpolated years will remove the correlation. This is one of the methods for correcting the problem of autocorrelation.

Two processes were examined to correct for autocorrelation. The first method, reported in columns 1 and 3 of Tables 2.6 and 2.7, deleted the data observations that were interpolated. This reduced the number of observations to 336 in the sample for all enrollment and 192 for the sample of publicly controlled institutions. The second correction method was the Cochrane-Orcutt procedure discussed previously. The results from this procedure are listed in columns 2 and 4 in Tables 2.6 and 2.7. A brief discussion of these results follows.

OLS results for Actual Data

The results for the OLS regressions on the actual data observations appear in Tables 2.6 and 2.7, columns 1 and 3.[9] The dependent variable of public enrollment had some problems. The dummy variable "data" was highly correlated with the variables that were constant across states. This led to the problem of singularity of the regressor matrix. To address this problem the dummy variable "data" was deleted from the regression. This regressions also had very large standard errors, implying there was still a problem among the

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[6]Note that the test was adjusted to account only for correlation across time, and was biased by measuring correlation across states.

[7]1 percent critical value for k=11, n=200, Greene, (1990).

[8]Johnston (1984), p 315.

[9]The following years have actual data: All institutions 1967, 1971, 1975, 1978, 1980, 1983, 1986, public institutions 1967, 1971, 1980, 1986.

regressors. Finally, the variable for national average private tuition (or cost) was removed from the regressors. This led to the results listed in the two tables.

The regression for all students did not have the aforementioned difficulties. The two regressions yield results similar to the full sample OLS results. The price of attending an in-state institution is negative and significant, as theory would suggest. The first column shows that the coefficient for out-of-state schools is positive, as expected. The regression that considered only public institutions found this coefficient to be negative, but insignificant.

The coefficient of high school graduates is significant and similar in magnitude to the full sample OLS results. For all institutions, the coefficient on the number of high school graduates is near 1. The sign of the coefficient on the unemployment rate is also consistent with the full sample OLS results. The magnitude, however, is doubled. The coefficient of the unemployment rate is significant in all four cases.

Cochrane - Orcutt Results

The Cochrane - Orcutt results are listed in columns 2 and 4 of Tables 2.6 and 2.7. The value of rho, the coefficient of correlation, ranges from 0.88 to 0.90, which indicates that there is positive serial correlation among the errors. However, there are some other problems that this specification brings to bear. The loss of significance in several variables is perhaps the most notable disadvantage.

The sign of the resident tuition coefficient is negative under the Cochrane-Orcutt model. This impact of an increase of tuition is small under this specification. Both of the dependent variables show a negative relationship between the tuition price of in-state college education and the number of enrollees. Although the coefficients are negative, they are not statistically significant. The coefficients of the total cost of attending a college in-state are shown here to be positive. This is counter to what theory and previous research would

suggest. However, it is important to note that the coefficients are not significant under either price measure. The implication is virtually inelastic demand for higher education in the state.

The other price measures, nonresident tuition and private school tuition, are also used in the estimation. The coefficients of tuition at institutions out of state were found to be positive in three of the estimations. These are the correct sign according to the theoretical model. They are not significant in any of the estimations. Only one sign disagrees with the theory.

The coefficient of the price of attending a private institution (tuition or total cost) is expected to have sign changes as before. It is expected to have a negative sign with the dependent variable for all institutions. The coefficients do support this hypothesis. However, they are not significantly different from zero in either case. The sign under the dependent variable of enrollment in publicly controlled institutions is expected to be positive. This is not the case in either the tuition or total cost measure. The signs of both private tuition and private costs are negative.

The coefficient of the measure of family income is expected to be positive. An increase in family income is expected to increase enrollment in college. However, under the corrected model, the coefficient is negative in all four specifications. It is not significant at the ten percent level in any of the models. The number of high school graduates is significant and positively related to the number of enrollees. This is consistent with what theory would suggest. The coefficients range from 0.87 to 0.93 across all specifications constructed here. This is very similar to the coefficients found in the simple OLS model. The coefficients are also found to be significant at the 1 percent level across all specifications.

The coefficient of relative salary, or returns to college education remain negative. Recall that this is the same sign as found in the OLS model. In the corrected model the coefficients are significant at the 5 percent level. The sign does not agree with what theory

would suggest. The results show that the rate of unemployment is significant under the dependent variable that considers only public school enrollment. Under this dependent variable the coefficients are negative. This would imply that the unemployment rate is best representing the ability of the student to work while attending college. If the student is less likely to hold a job while in college (i.e. the unemployment rate increases) the higher the cost of attending school and the less likely the student is to attend college. This contradicts the findings under the OLS model.

The measures for school quality are found to be negative for public elementary/secondary schools and positive for higher education spending. The negative sign of elementary and secondary school spending disagrees with what the OLS results suggests the result increased spending would be at that level. The coefficient of higher education spending is correct according to theory, but is not significantly different from zero in any of the four specifications tested here.

The corrected model brings to light some new problems. While the OLS model is shown to suffer from serial correlation, it also corresponds most closely to theory. The model which corrects for the serial correlation provides two areas of concern: the large loss of significance and the sign changes. The model, however, still explains a large portion of the variance of the dependent variable, as measured by the R-Squared statistic. To the extent that the estimates which only use truly observed tuition do not suffer from serial correlation, those results may be considered the preferred results.

There are many implications for both the OLS model and the corrected model. There are some other approaches that might be considered in estimating the demand for higher education at the national level. These will be discussed in Chapter 4.

Table 2.1. Brief definitions of variable names.

Name	Definition
Dependent Variables:	
ftsall	first-time undergraduate students in all institutions of higher education, both privately and publicly controlled
ftspub	first-time undergraduate students in publicly controlled institutions of higher education
Independent Variables:	
inst	real resident tuition in the own state.
outo	real average nonresident tuition in adjoining states
prvt	real national average of private tuition in the United States
rmbrd	real own state annual room and board
rmo	real average of adjoining states room-and-board
prvrb	real national average room-and-board of private schools
incost	real sum of in-state tuition and room-and-board
outocost	real sum of average tuition and room-and-board in adjoining states
prvc	real sum of private tuition and private room-and-board
incp	real mean income per capita in the own state
hsgrad	number of high school graduates in the own state
rels	national average salary of college graduates relative to high school average salary
pexp	real per pupil spending in elementary and secondary public school
lsub	a proxy measure of real per student state spending on higher education
data	a dummy variable to account for different source the dependent variable
draft	a dummy variable used to account for the draft deferment
unempl	unemployment rate of 18-19 year males in the U.S.

Table 2.2 Universities selected to represent the state when *Barron's Guide to Colleges* and *The College Blue Book* were the source for information on tuition and room-and-board.

State	Institution	State	Institution
Alabama	Auburn	Montana	Montana State Univ.
Alaska	Univ. of Alaska at Fairbanks	Nebraska	Univ. of Nebraska at Lincoln
Arizona	Arizona State Univ.	Nevada	Univ. of Nevada at Reno
Arkansas	Univ. of Arkansas at Fayetteville	New Hampshire	Univ. of New Hampshire
California	Univ. of California at L. A.	New Jersey	Rutgers Univ. & College
Colorado	Univ. of Colorado Boulder	New Mexico	Univ. of New Mexico
Connecticut	Univ. of Connecticut	New York	State Univ. of NY at Buffalo
Delaware	Univ. of Delaware	N. Carolina	Univ. of N. Carolina Chapel Hill
Florida	Univ. of Florida Gainsville	N. Dakota	Univ. of N. Dakota
Georgia	Univ. of Georgia Athens	Ohio	Ohio State Univ.
Hawaii	Univ. of Hawaii Manoa	Oklahoma	Oklahoma State Univ.
Idaho	Univ. of Idaho Moscow	Oregon	Oregon State Univ.
Illinois	Univ. of Illinois U/C	Pennsylvania	Pennsylvania State Univ.
Indiana	Indiana Univ. at Bloomington	Rhode Isl.	Univ. of Rhode Island
Iowa	Iowa State Univ.	S. Carolina	Univ. of S. Carolina
Kansas	Univ. of Kansas	S. Dakota	S. Dakota State Univ.
Kentucky	Univ. of Kentucky	Tennessee	Univ. of Tennessee at Knoxville
Louisiana	Louisiana State Univ. A&M	Texas	Univ. of Texas at Austin
Maine	Univ. of Maine Orono	Utah	Univ. of Utah
Maryland	Univ. of Maryland College Park	Vermont	Univ. of Vermont
Massachusetts	Univ. of Massachusetts Amherst	Virginia	Virginia Polytech.
Michigan	Michigan State Univ.	Washington	Univ. of Washington
Minnesota	Univ. of Minnesota Twin Cities	W. Virginia	W. Virginia Univ.
Mississippi	Mississippi State Univ.	Wisconsin	Univ. of Wisconsin at Madison
Missouri	Univ. of Missouri at Columbia	Wyoming	Univ. of Wyoming

Table 2.3 Mean and standard deviations of variables used in the empirical analysis.

Variable (n=960)	Mean (x)	St. Dev (x)	Mean (log(x))	St. Dev. (Log(x))
ftsall	43428.260	50154.940	10.208	0.979
ftspub[a]	31717.888	40376.768	9.870	0.995
inst	12.075	5.0125	2.408	0.415
outo	32.253	8.055	3.445	0.235
prvt	52.186	7.727	3.945	0.140
incost	40.231	9.422	3.669	0.222
outcost	66.361	42.631	4.124	0.301
prvc	81.463	9.803	4.393	0.113
incp	107.891	19.412	4.664	0.183
hsgrad	54160.001	52284.340	10.475	0.958
rels	1.618	0.009	0.479	0.058
pexp	1862.722	1126.254	3.243	0.264
lsub	0.041	0.39	-3.575	0.914
unempl	15.445	0.400	2.717	0.201

a.) n=672

Table 2.4 OLS results for first-time students in all institutions and public institutions, with price measure for tuition only.

	lnftsall (1)	lnftsall (3)	lnftspub (9)	lnftspub (11)
intercept	0.065	-1.287 ***	0.525	0.872
	(0.712)	(0.394)	(0.934)	(0.538)
lninst	-0.158 ***	-0.161 ***	-0.275 ***	-0.275 ***
	(0.023)	(0.023)	(0.028)	(0.028)
lnouto	0.221 ***	0.189 ***	-0.098	-0.090
	(0.047)	(0.045)	(0.062)	(0.060)
lnprvt	-0.384 **		0.092	
	(0.168)		(0.203)	
lnincp	0.095	0.094	0.092	0.092
	(0.096)	(0.096)	(0.118)	(0.118)
lnhsgrad	0.929 ***	0.931 ***	0.834 ***	0.834 ***
	(0.016)	(0.016)	(0.020)	(0.020)
lnrels	-0.403	-0.559 *	-1.055 **	-1.047 **
	(0.332)	(0.326)	(0.471)	(0.471)
lnpexp	0.256 ***	0.256 ***	0.387 ***	0.389 ***
	(0.064)	(0.064)	(0.081)	(0.081)
lnlsub	0.039 **	0.035 **	0.150 ***	0.151 ***
	(0.017)	(0.017)	(0.021)	(0.020)
data	-0.157 ***	-0.226 ***	-0.236 ***	-0.215 ***
	(0.055)	(0.046)	(0.088)	(0.076)
draft	-0.011	0.036	0.024	0.012
	(0.039)	(0.033)	(0.047)	(0.040)
lnunempl	0.235 ***	0.235 ***	0.266 ***	0.261 ***
	(0.069)	(0.069)	(0.089)	(0.088)
n	960	960	672	672
R-Squared	0.9342	0.9338	0.9277	0.9276
F Value	1222.938	1338.785	769.389	847.323
Durbin Watson	0.30374	0.30655	0.34640	0.34544

( ) Standard Error
* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

Table 2.5 OLS results for first-time students in all institutions and public institutions, with price measure for total cost (the sum of tuition and room-and-board).

	lnftsall (2)	lnftsall (4)	lnftspub (10)	lnftspub (12)
intercept	0.181	-1.171 ***	1.444	1.318 **
	(0.819)	(0.414)	(1.107)	(0.562)
lnincost	-0.100 *	-0.122 **	-0.434 ***	-0.436 ***
	(0.056)	(0.055)	(0.070)	(0.069)
lnoutoc	0.050	0.043	-0.117 **	-0.118 ***
	(0.034)	(0.034)	(0.046)	(0.046)
lnprvc	-0.329 *		-0.028	
	(0.172)		(0.214)	
lnincp	0.269 ***	0.262 ***	0.243 **	0.243 **
	(0.095)	(0.095)	(0.118)	(0.118)
lnhsgrad	0.914 ***	0.918 ***	0.864 ***	0.864 ***
	(0.016)	(0.016)	(0.021)	(0.021)
lnrels	-0.375	-0.535	-1.438 ***	-1.440 ***
	(0.353)	(0.344)	(0.493)	(0.492)
lnpexp	0.176 ***	0.184 ***	0.376 ***	0.376 ***
	(0.066)	(0.066)	(0.085)	(0.085)
lnlsub	0.056 ***	0.052 ***	0.142 ***	0.142 ***
	(0.017)	(0.017)	(0.022)	(0.021)
data	-0.172 ***	-0.224 ***	-0.241 ***	-0.247 ***
	(0.054)	(0.046)	(0.090)	(0.077)
draft	0.033	0.063 *	0.076	0.079 *
	(0.039)	(0.035)	(0.047)	(0.042)
lnunempl	0.239 ***	0.252 ***	0.200 **	0.203 **
	(0.071)	(0.071)	(0.095)	(0.092)
n	960	960	672	672
R-Squared	0.9308	0.9305	0.9228	0.9228
F Value	1159.443	1271.451	717.454	790.372
Durbin Watson	0.28627	0.28928	0.32041	0.32120

( ) Standard Error
* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

Table 2.6 OLS results for actual data observations and nonlinear results from the Cochrane - Orcutt procedure for autocorrelation.

Dependent Variable	log First Time Students (actual data)	lnfts w/nonlinear constraint	Log First Time Students /public (actual data)	lnpub w/nonlinear constraint
Intercept	-0.221	0.032 ***	1.332	0.785 ***
	(1.118)	(0.095)	(1.270)	(0.287)
lninst	-0.131 ***	-0.017	-0.263 ***	-0.075
	(0.038)	(0.058)	(0.051)	(0.071)
lnouto	0.188 **	0.141	-0.107	-0.087
	(0.078)	(0.109)	(0.122)	(0.165)
lnprvt	-0.417	-0.223		-1.072 **
	(0.280)	(0.164)		(0.524)
lnincp	0.121	-0.174	0.188	-0.052
	(0.163)	(0.129)	(0.240)	(0.169)
lnhsgrad	0.936 ***	0.897 ***	0.824 ***	0.930 ***
	(0.027)	(0.048)	(0.039)	(0.055)
lnrels	-1.420	-0.528 **	-4.391 **	-0.867 **
	(0.910)	(0.221)	(2.142)	(0.346)
lnpexp	0.241 **	-0.164 **	0.373 **	-0.083
	(0.107)	(0.069)	(0.162)	(0.103)
lnlsub	0.041	0.005	0.193 ***	0.008
	(0.030)	(0.016)	(0.043)	(0.019)
data	-0.111	-0.226 ***		0.297
	(0.147)	(0.022)		(0.443)
draft	-0.031	0.025	0.096	0.016
	(0.048)	(0.022)	(0.073)	(0.027)
lnunempl	0.534 ***	0.010	0.596 ***	-0.219 **
	(0.174)	(0.068)	(0.194)	(0.100)
rho		0.898 ***		0.885 ***
		(0.015)		(0.019)
n	336	816	192	480
R-Squared	0.9385	0.9829	0.9322	0.9826
F-Stat / MSE	449.706	0.01664	278.153	0.01760

( ) Standard Error
* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

Table 2.7 OLS results for actual data observations and nonlinear results from the Cochrane - Orcutt procedure for autocorrelation with price measure for total cost (the sum of tuition and room-and-board).

Dependent Variable	log First Time Students /all (actual data)	lnfts w/nonlinear constraint	Log First Time Students /public (actual data)	lnpub w/nonlinear constraint
Intercept	-0.557	0.325 ***	1.749	0.695 ***
	(1.258)	(0.094)	(1.296)	(0.255)
lnincost	-0.069	0.041	-0.455 ***	0.091
	(0.094)	(0.119)	(0.137)	(0.168)
lnoutoc	0.046	0.125	-0.119	0.065
	(0.056)	(0.113)	(0.091)	(0.165)
lnprvc	-0.255	-0.231		-1.113**
	(0.280)	(0.151)		(0.449)
lnincp	0.277 *	-0.184	0.463 *	-0.106
	(0.162)	(0.130)	(0.237)	(0.168)
lnhsgrad	0.918 ***	0.875 ***	0.850 ***	0.907 ***
	(0.028)	(0.052)	(0.041)	(0.064)
lnrels	-0.909	-0.494 **	-4.870 **	-0.783 **
	(0.932)	(0.225)	(2.128)	(0.331)
lnpexp	0.169	-0.177 **	0.326 *	-0.140
	(0.111)	(0.069)	(0.168)	(0.103)
lnlsub	0.063 **	0.005	0.192 ***	0.007
	(0.030)	(0.016)	(0.045)	(0.019)
data	-0.217	-0.229 ***		0.239
	(0.137)	(0.022)		(0.445)
draft	0.005	0.026	0.200 **	0.017
	(0.050)	(0.021)	(0.079)	(0.024)
lnunempl	0.437 **	0.006	0.420 **	-0.178 *
	(0.170)	(0.069)	(0.200)	(0.097)
rho		0.905 ***		0.900 ***
		(0.015)		(0.019)
n	336	816	192	480
R-Squared	0.9361	0.9829	0.9274	0.9826
F-Value	431.286	0.01663	258.508	0.01759

( ) Standard Error * Significant at the 10% level
** Significant at the 5% level *** Significant at the 1% level

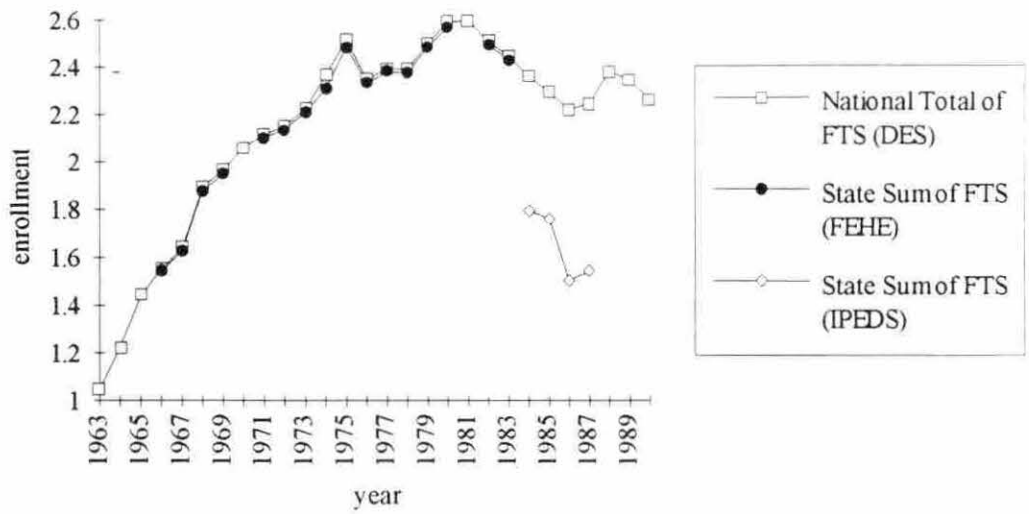

Figure 2.1 National measure of first time students and the sum of the individual state data used in the empirical analysis.
Sources: DES: *Digest of Educational Statistics*, 1991
FEHE: *Fall Enrollment in Higher Education*
IPEDS: *Integrated Post-Secondary Education Data System*.

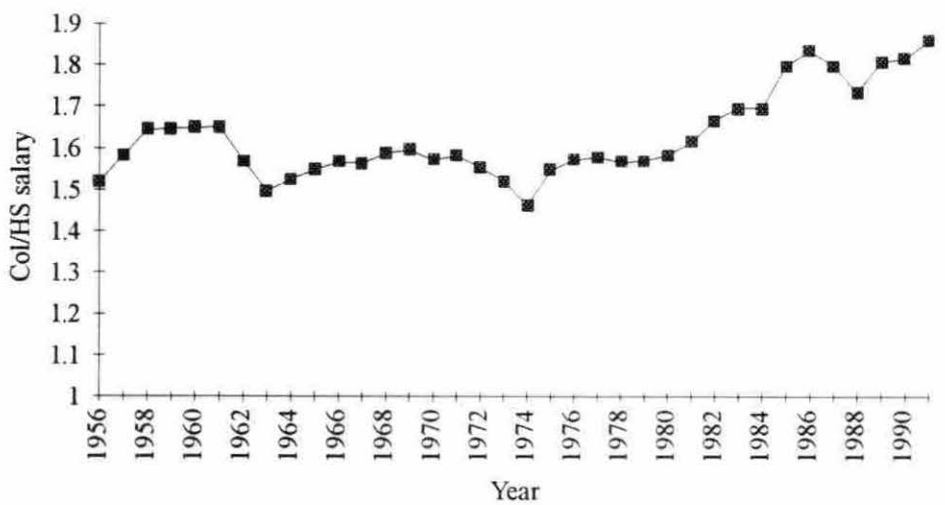

Figure 2.2 National mean college salary over high school salary, 1956 - 1992.
Source: *Current Population Surevy*.

CHAPTER 3

NONRESIDENT ENROLLMENT DEMAND AT IOWA STATE UNIVERSITY

The factors that influence enrollment at an individual institution are of particular interest in this chapter. The representative institution examined is Iowa State University. Iowa State University is under increasing pressure to maintain and increase revenues from tuition. Budgetary pressures at the state and federal levels suggest that governmental support of the University is unlikely to increase at the same rate as in the past. As a result, tuition revenue is likely to become an increasingly important source of revenue for Iowa State University.

Iowa State is especially interested in nonresident enrollment. As mentioned in Chapter 1, a nonresident student pays nearly three times the tuition of resident students. Iowa State's three most important sources of nonresident enrollments are Illinois, Minnesota and Nebraska. Iowa State's competitors are most likely to be schools that are geographically near ISU. The University will need to examine the tuition and costs that competing universities in these states are currently charging. They must remain competitive in price if they are targeting students who are sensitive to the price of attending college.

This chapter will examine many of the same factors examined in Chapter 2 including relative tuition, family income, school quality, and the unemployment rate. Additional factors can be included in the study because an individual institution is being examined. Among these additional factors is a measure of how well Iowa State is known in a particular area. Lower costs of obtaining information about the institution would make students more likely to attend. The geographical and psychological distance from the student's home to the institution would also factor into the decision to attend ISU.

Theoretical Model Reviewed

The model of human capital, discussed in Chapter 1, also lends itself to the examination of enrollment at a particular institution; however, a few minor changes are required. The modification comes from the increase in the choices available to the high school graduate considering college. Previously the decision was dichotomous. However, by examining a single institution, the choice is no longer attend versus not attend. The choice becomes attend the institution in question, attend a competing institution, or not attend at all. By grouping two of these options we can use the same framework as in the previous model.

The student's choice can be modeled as follows. As before, assume that there are life-time income streams from each of the above three options. The income streams take into account both the costs and returns resulting from the choices. Let them be represented as follows:

Y_{isu} the income stream from attending ISU

Y_{inst} the income stream from attending a competing institution

Y_{hs} the income from not attending a college and entering the labor force

where the individual subscript has been suppressed for convenience. Then, by assumption, an individual will choose the option that yields the largest life-time income stream. Thus we can model the individual's choice to attend ISU as

$$p_{isu} = \begin{cases} 1 & \text{if } Y_{isu} \geq Max(Y_{inst}, Y_{hs}) \\ 0 & \text{otherwise} \end{cases} \qquad (3.1)$$

where p_{isu} is the discrete choice of whether or not to pick Iowa State. The individual's choice to pick the other two options can be represented in two forms. The first would be to list two additional choices of the form

$$p_{inst} = \begin{cases} 1 & \text{if } Y_{inst} > Max(Y_{isu}, Y_{hs}) \\ 0 & \text{otherwise} \end{cases} \qquad (3.2)$$

$$p_{hs} = \begin{cases} 1 & \text{if } Y_{hs} > Max(Y_{isu}, Y_{inst}) \\ 0 & \text{otherwise} \end{cases} \qquad (3.3)$$

The second method of modeling the remaining two alternatives would be to combine (3.2) and (3.3).

$$p_{other} = \begin{cases} 1 & \text{if } Y_{isu} < Max(Y_{inst}, Y_{hs}) \\ 0 & \text{otherwise} \end{cases} \tag{3.4}$$

Thus, the probability that the individual does not attend ISU is

$$p_{other} = 1 - p_{isu} \tag{3.5}$$

The second method of modeling the remaining two choices is used in this research. This is done because data on those individuals who enter the labor force and those who choose other institutions are not available in this research. This reduces the decision the high school graduate faces to attending ISU versus not attending ISU, which includes at least two options (entering another school or the labor force).

In a given year t, enrollment from a given state at Iowa State can be modeled by summing over individual "pick" decisions as follows:

$$isuenr_{s,t} = \sum_{i=1}^{N_{s,t}} p_{isu,i} \tag{3.6}$$

where $N_{s,t}$ is the eligible population, which in this research is assumed to be the high school graduates in a particular state and the subscript i refers to individual graduates in the state.

The statistical model used in this analysis is ordinary least squares (OLS). The model is of the form

$$isuenr_{s,t} = \beta_0 + X_{s,t}\beta + \varepsilon_{s,t} \tag{3.7}$$

where

$isuenr_{s,t}$ = the number of students enrolling at Iowa State University from state (s), and year (t).

β_0 = a constant term

$X_{s,t}$ = a vector of hypothesized factors of college enrollment for each state (s), and year (t).

β = a vector of coefficients

$\varepsilon_{s,t}$ = an error term for each state (s), and each year (t).

The vector of factors influencing the decision to enroll at Iowa State University includes the following variables. There are up to four measures of the price of attending college. Two of the prices represent the cost of attending ISU. The other prices represent the cost of attending an institution in the student's home state. The four measures of price are ISU nonresident tuition, ISU room-and-board, the student's home state resident tuition, and the student's home state room-and-board. The four price measures can be reduced to two by summing tuition and room-and-board for each institution. Also included as independent variables are the number of high school graduates from each state, the number of ISU alumni in each state and the distance of each state from ISU. Two proxy measures of the quality of education in each state are also used. These are the spending per pupil in public elementary and secondary schools and a proxy measure for the per pupil spending for institutions of higher education. Another measure included in this study is a measure of the returns to education, as used in the previous study.

Discussion of Variables

This project utilized data for each state in the United States. Data for Washington, D.C., was omitted. Data was recorded in current (nominal) dollars and changed to constant (real) dollars by the Consumer Price Index (CPI) for 1987. The time period used for this report is 1973 to 1990. The following is the list of variables used and their sources. The variable definitions are summarized in Table 3.1. The mean and standard deviations of the variables used in the empirical analysis appear in Table 3.2.

Variable Definitions and Sources

*Iowa State University Enrollment: This is the number of new ISU fall undergraduate enrollees from each state. This data was provided by Sue Gardner, from the *Iowa State University Enrollment Services Annual Statistical Report*.

*Iowa State University Tuition and Fees: Annual nonresident tuition and fees were used as a measure of the cost of attending ISU for nonresidents. The annual measure automatically adjusts for the change from quarters to semesters. This data was also provided by Sue Gardner, from the *Iowa State University Enrollment Services Annual Statistical Report*.

*Iowa State University Room-and-Board: This was used as a measure of annual cost of living at ISU. The series was adjusted to account for the move from quarters to semesters which occurred in 1981. This data was provided by Sue Gardner, from the *Iowa State University Enrollment Services Annual Statistical Report*.

*Alumni: This is the number of Iowa State alumni living in each state. Data were provided by the ISU Alumni Association and the *Iowa State Fact Book*. The data for 1983 were not available. For that year, linear interpolation between the years of 1982 and 1984 was used.

*Distance: The distance from Ames, Iowa to the closest border of each state.

*National College Salary: Same variable as defined in Chapter 2.

*National High School Salary: Same variable as defined in Chapter 2.

*National Relative Salary: Same variable as defined in Chapter 2.

*Higher Education Expenditures: Same variable as defined in Chapter 2.

*Local Subsidy: Same variable as defined in Chapter 2.

*High School Graduates: Same variable as defined in Chapter 2.

*Own State Tuition: Same variable as defined in Chapter 2.

*Own State Room-and-Board: Same variable as defined in Chapter 2.

*Public School Expenditure: Same variable as defined in Chapter 2.

*Consumer Price Index (1987): Same variable as defined in Chapter 2.

*Per capita Income: Same variable as defined in Chapter 2.

*Unemployment rate: Same variable as defined in Chapter 2.

Several regions of the United States were examined in more detail. These regions were presumed to be composed of Iowa State's strongest competitors for nonresident students. The regions included:

*Big 8: Colorado, Kansas, Missouri, Nebraska, and Oklahoma.

*Big 10: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

*Border: Illinois, Minnesota, Missouri, Nebraska, South Dakota, and Wisconsin.

*Upper Midwest (U M W): Colorado, Illinois, Indiana, Kansas, Kentucky, Michigan, Minnesota, Missouri, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming.

A Graphical Introduction to Variables Influencing Nonresident Enrollment at Iowa State University

This study will concentrate on examining factors affecting new out-of-state enrollment at Iowa State University. New enrollees will be the most sensitive to changing economic conditions and other forces affecting the decision to attend college, as found by Chressanthis (1986). Because it is costly to switch schools, more senior students will be less sensitive to these forces. Since approximately 6 of 10 new ISU enrollees complete their degrees at Iowa State, increasing new enrollees yields several years of additional revenue. In addition, increases in new enrollees signals additional increases in enrollment in subsequent years, provided that the factors which led to the increases do not change. Thus, if changes in tuition policies lead to 200 new nonresident enrollees, this will imply a long run increase in total

enrollment of much more than 200. For example, a total attrition rate of .4 over four years (i.e., 40 percent of students leave ISU over a four year period) corresponds to an annual attrition rate of about 0.157 percent. Thus, a permanent increase in current nonresident enrollment of 200 implies a long term increase in total nonresident enrollment of 630 students.[1] The response of new enrollees to changes in external forces will give a more accurate picture of the long-term enrollment trends at Iowa State. Therefore, a careful examination of new enrollment may give some insight as to how ISU might achieve its future tuition revenue and enrollment goals.

The time path of nonresident enrollment at Iowa State has seen dramatic changes over the past 20 years, as shown in Figure 3.1. The number of new nonresident fall enrollees has a time path with a single peak, in 1983. In 1973, the number of nonresidents enrolling at ISU was near 1,000. After having relatively constant levels of new out-of-state enrollees for the next 5 years, ISU began to see an increase of approximately 100 nonresidents per year. The peak in 1983 was about 1,600 new nonresidents. From 1983 to 1990, enrollment declined to a low of 800. There has been a small increase in the number of nonresidents enrolling at ISU in the past three years, but the number enrolling is significantly below that of the early 1980s.

Iowa State does not draw enrollees evenly across all 50 states. Therefore, it is important to look at enrollment data from specific states. The six states with the largest share of nonresident enrollment at ISU are listed in Table 3.3. Illinois has clearly had the largest share of nonresident enrollment at ISU. The share of nonresidents from Illinois ranges from 34 to 57 percent. The second largest share comes from Minnesota. Their share ranges from 11 percent in 1974 to 21 percent in 1990. The third largest share is from Nebraska, which ranges from 5 to 12 percent. The last three have relatively small shares of ISU nonresident enrollments.

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[1] $200 + (1- 0.157)200 + (1-0.157)^2200 + (1-0.157)^3200 = 630$

Illinois, the largest source of new nonresident enrollees, has a time trend that mimics the nonresident enrollment from all states and is shown in Figure 3.2. There was a steady increase from 1973 to 1983, where a peak of near 850 students was reached. After 1983 the number of Illinois enrollees at ISU fell until 1990. The increase in enrollees from Illinois after 1990 seems to be proportionally smaller than that of all nonresident enrollments.

Illinois nonresident students have made up the majority of nonresident students at ISU (see Table 3.3). In 1973, 34 percent of the nonresidents at ISU were from Illinois. This peaked in 1984 when Illinois students made up 57 percent of the nonresidents. The percentage has declined since then: in 1992, 38 percent of nonresidents were from Illinois.

There are other states, such as Minnesota and Nebraska, which have a significant number of enrollees as well. Figure 3.3 shows the time paths of the new fall enrollees from these two states. Again, the trend over time is much like that of nonresident enrollment from all states, with a larger than proportional increase in the number of enrollees from Minnesota and Nebraska in the early 1990s. The share of students from these two states have different time trends. Table 3.3 shows that Minnesota's share of nonresident students peaked in 1990 at 21 percent. Prior to 1990, the share was under 15 percent. In 1992 the share of nonresidents from Minnesota was 19 percent. The share of nonresidents from Nebraska has ranged between 7 and 12 since 1975.

In the other border states, only Wisconsin has the same pattern. Missouri and South Dakota do not show a clear pattern. This is shown in Figure 3.4. The share of nonresidents from these three states has also remained relatively constant. Wisconsin, the largest of these three, has ranged from 2 to 7 percent. The share of students from Missouri and South Dakota ranged from 1 to 5 percent over the sample.

A factor that is important in the decision to enroll in college is the cost of doing so. The primary direct cost of attending college is tuition. The time paths of the tuition measures

are shown in Figures 3.5 and 3.6. Figure 3.5 shows the real nonresident tuition at Iowa State for 20 years, 1970 to 1990. Clearly 1980 saw the lowest real tuition level of the past 20 years. Recall that it was in the early 1980s that ISU saw the largest level of nonresident enrollment. Then, from 1980 to 1983, tuition at ISU grew slowly, increasing only $500 over the four years. In 1983 ISU saw the largest number of nonresident enrollees. After 1984 nonresident tuition increased very rapidly. This rapid increase continued until 1989, when the level was nearly 2000 dollars above the low of 1980. The time path of nonresident enrollment also shows a decline of nearly 800 nonresident students from 1983 to 1990. The time paths of these two variables indicate that it is very likely that enrollment levels are significantly influenced by tuition levels.

The degree of competitiveness of ISU is based, in part, on the cost of attending ISU relative to other institutions. Figure 3.6 shows real ISU nonresident tuition with the national mean value of real nonresident tuition in the U.S. It indicates that from 1970 to the later 1980s, the tuition at Iowa State University was below the national average. However, in 1987 ISU nonresident tuition jumped above the national average nonresident tuition. This analysis examines the choice of attending an in-state university and attending ISU. Therefore, Figure 3.7 shows the mean value of resident tuition and ISU nonresident tuition. As is characteristic of nonresident tuition nationally, nonresident tuition at ISU is over 3 times the national average of resident tuition. The institutions that are most likely to be competing for the students who are considering enrolling at ISU include the surrounding states. Figures 3.8 and 3.9 show ISU nonresident tuition and resident tuition in surrounding states such as Illinois, Minnesota, Wisconsin, Missouri, Nebraska and South Dakota. Each of the measures was normalized to be one in 1970. These Figures indicate that after 1984, Iowa State's nonresident tuition has been increasing faster than resident tuition in all of these states, except

Missouri. It is very likely that students have passed over ISU in favor of the alternatives available in their own states.

A second factor that is likely to influence ISU nonresident enrollment is the eligible population. This analysis uses the number of high school graduates as the eligible population. Nationally, the number of high school graduates has declined since the late 1970s. This time trend is shown in Figure 3.10. By 1990, the number of high school graduates was 10 percent below the level of 1970 and 20 percent below the baby boom peak in 1976. Considering that the number of enrollees from surrounding states is substantially higher than other states, examining the time path of high school graduates from these states is especially relevant to ISU. Figures 3.11 through 3.13 show the number of high school graduates from each of the surrounding states. Illinois and Minnesota have time paths nearly identical to the national time trend. Illinois had higher percentage increases in high school graduates than was true nationally. The percentage decline in Minnesota is consistent with the national trends since 1976, but has been almost 30 percent in Illinois since 1976. Missouri had a larger increase in the late 1970s than the national average, but experienced similar declines in the 1980s. Wisconsin, Nebraska and South Dakota had declines in the 1980s that were more severe than the national average. These time series indicate that the eligible population of nonresident ISU students has declined significantly over the last decade. Furthermore, these declines have been particularly pronounced in states from which Iowa State draws most of its nonresident students.

However, there is at least one reason to question a purely demographic explanation for declining nonresident enrollment. In 1990, for example, Illinois had just over 100,000 high school graduates. In 1990, ISU had almost 400 new fall enrollees from Illinois, less than one-half of one percent of the Illinois high school graduates. Illinois high school graduates began declining in 1976 and continued declining through 1986, as shown in Figure 3.11. Notice,

however, from Figure 3.2, that the number of new enrollees from Illinois increased most rapidly from 1976 to 1983. Therefore, adverse demographic shocks to the population of high school graduates do not necessarily translate into proportional reductions in nonresident enrollments. While there may be a connection between the number of high school graduates and nonresident enrollment, as shown in the later 1980s, there may be ways of overcoming the effect. ISU may be able to intensify marketing efforts and increase the market share of the other states' shrinking high school graduation classes to counteract the population decline.

The trend of college enrollment at the national level seems to follow the trend of high school graduates more closely than the ISU enrollment does (See Figures 1.1, 3.10, and 3.2). For example, in 1976 the number of high school graduates peaked. The nearest peak in first-time freshmen enrollment nationally appears in 1981. The peak in ISU enrollment did not occur until 1983. The 20 percent decline in high school graduates from 1976 to 1990 corresponds to a decline of approximately 7 percent in first time enrollees at all colleges (from 1977 to 1990), thus casting more doubt on the purely demographic explanation of enrollment.

The returns to education are also examined in this model. The time trend of relative salaries, Figure 3.14, shows a significant increase since the mid 1970s. In 1974, the relative salary was at a thirty year low. Since the early 1980s relative returns to college education have increased at unprecedented rates. Theory would suggest that this would increase the number of people enrolling in college. Examining the trends of relative salaries and ISU enrollment indicate that ISU does not appear to be benefiting from the increased returns to enrollment. However, simple examination of the time trend does not indicate a connection between the two variables exists. The impact of the independent variables on enrollments will be determined with the OLS regressions.

The dramatic increase in returns to college education will have the largest impact on those students who would not have attended college previously. These are the students who

would be most sensitive to price and less interested in paying the higher cost of nonresident tuition. This may explain why ISU has not seen an increase in enrollments during the period of increasing returns to education.

Out-of-state students face costs beyond the cost of tuition. These costs can be examined for an individual institution. Distance from home plays a part in the decision of a student to enroll at ISU. This enters the decision process as the direct costs of travel, as well as the psychological costs of being farther away from family and friends. The costs of travel are significant, especially if the student has a large amount of furnishings to transport to Ames. Perhaps equally important is that the increased distance makes a weekend trip home more difficult, if not impossible. The same is the case for parents wishing to take a trip to visit their son or daughter.

Some of the psychological costs of distance may be decreased if the student is familiar with Iowa State University. An excellent source of information about ISU is family, friends, and other acquaintances who have attended ISU in the past. Areas with more ISU alumni are likely to provide more contacts with prospective students and, therefore, increase the student's knowledge about ISU. Increased numbers of alumni also lower the information search costs of the decision whether or not to attend Iowa State University.

The Iowa State University alumni are scattered throughout the U.S. In 1989, the largest number of alumni in a single state, 48,001, was found in Iowa. Illinois has the second largest number of alumni, with 10,195. California, Minnesota, and Texas follow with 8,758, 7,191, and 4,901 ISU alumni, respectively.

All of these factors are potentially very important for ISU enrollment. It is important that decisions on tuition at Iowa State University take into account these factors to ensure that an adequate number of out-of state students will attend ISU. The degree to which students have passed over ISU in favor of other institutions as a result of tuition increases

hinges on the elasticity of nonresident enrollment at ISU. The elasticity with respect to tuition will explain the impact on enrollment at ISU in the following manner, if it is inelastic (less than 1 in absolute value), a one percent change in tuition will lead to less than one percent change in enrollment. If the elasticity of nonresident enrollment with respect to nonresident tuition is elastic (greater than 1 in absolute value), a 1 percent change in tuition will lead to more than a 1 percent change in enrollment.

As budgetary pressures make tuition revenues relatively more important, the University must not make decisions that will tend to decrease these revenues. This chapter is an attempt to quantify the importance of the factors discussed above on enrollment. It is hoped that the results can be used to establish Iowa State's relative competitive position for out-of-state students, and to determine whether further tuition increases would raise or lower tuition revenues.

Discussion of Empirical Analysis

The method used to find the impact of changes in these factors is Ordinary Least Squares (OLS) Regression. The natural logarithms of the variables were used in the regression analysis. This will make the coefficients of the regressions interpretable as elasticities. The elasticities reveal the percentage impact on Iowa State University nonresident enrollment from a one percent change in an independent variable. The drawback of this specification is that some states may generate no new fall enrollees at ISU in some years. Because of the mathematical problem that the natural logarithm of zero is undefined, 0.1 was added to ISU enrollment before taking the natural logarithm. The bias from this adjustment is small.[2]

Each state in each year served as an observation. The analysis covers 49 states over 18 years, 1973 to 1990. Data was not available for countries outside the United States. The

[2]A discussion of the bias appears in the appendix.

dependent variable, new freshman enrollment for each state, was regressed on the natural logarithms of the following variables: ISU nonresident tuition, ISU room-and-board (or total ISU costs, defined as the sum of the ISU nonresident tuition and room-and-board), own state resident tuition, own state room-and-board (or total own state costs), per capita income, public school per student expenditures, state support of local universities, the number of high school graduates, the number of ISU alumni, the distance from ISU, the ratio of college to high school salaries, and the current unemployment rate. The variable definitions are summarized in Table 3.1

The models were run on the full sample and subsamples representing ISU's closest competitors for nonresident students. These include border states, the upper midwest and the states in the Big 8 and Big 10 athletic conferences. The latter samples yielded less reliable results, presumably because of their smaller sample sizes.

Discussion of Empirical Results

The results from four specifications of the model are presented in Tables 3.4 through 3.7. The first two tables list regression results that use the total cost measures rather than tuition and room-and-board separately. The second table, Table 3.5, lists results for total costs but does not include the measure for the quality of higher education, lnlsub. These regressions seem to give the most reliable results because the tuition and room-and-board considered separately are likely to be correlated. Tables 3.6 and 3.7 list regression results for the measures of tuition and room-and-board. The last table, as before, does not consider the proxy measure for quality of higher education, lnlsub. All of the models used the natural logarithm of all variables as previously discussed, implying that the coefficients from the regressions are the elasticities. The first two tables will be discussed in detail followed by a brief discussion of the last two tables.

OLS Results with Total Cost Measures

The most important result from this analysis, for the policy makers at ISU, is the coefficient on ISU cost. Across both specifications and for all but one sample, the elasticity of nonresident enrollment with respect to nonresident tuition is greater than one in absolute value. The only exception is the Big 10 sample for which the coefficient is below one but not significantly different from zero. The smallest significant coefficient is for the entire sample. The coefficients for ISU costs for the entire sample are -1.003 and -1.092, as shown in Tables 3.4 and 3.5. The other coefficients range from -1.780 to -4.207. These results suggest that a 1 percent increase in ISU costs will lead to a more than 1 percent decrease in ISU enrollees, especially from the states considered in the subsamples.

This reveals some important information about maintaining tuition revenues and nonresident enrollment at Iowa State University. An elasticity greater than one implies that a one percent increase in ISU costs would lead to a greater than 1 percent decline in out-of-state enrollment. Given that the marginal cost of adding a student to the University is negligible, this implies that revenues from tuition at best remained the same, while losing nonresident enrollees. This supports the more recent policy to hold back tuition increases and offer partial tuition scholarships to qualified out-of-state students. The results suggest that the resulting enrollment increases would more than pay for such cuts. A discussion of the possible revenue gains from tuition or cost adjustments is taken up at the end of this chapter.

Another factor that is important in determining enrollment at ISU is physical distance from the University. The coefficient for distance ranges from -0.914 to -2.858 and is significant in each sample. This implies that distance is a relatively strong factor in determining nonresident enrollment at Iowa State. Distance was not considered in the border states due to lack of variation for the sample.

The evidence suggests that the effect of distance on enrollment is more than proportional. In other words, a one percent increase in the distance from ISU will decrease enrollment by more than one percent. Although Iowa State University cannot control where prospective students live, ISU can use these results to increase the effectiveness of their marketing and recruiting efforts. Since nonresident students closer to ISU are more likely to attend, additional recruiting efforts should be more effective the closer the prospective student is to Ames.

It is also clear from the results that the number of alumni in a state is positively related to the number of students attending ISU. The coefficients are positive, ranging from 0.135 to 0.433, and significant for all samples. The Big 8 is the exception with a coefficient of -0.30 that is not statistically different from zero. Since the coefficients are less than one, the impact of an increase of alumni in one state will yield a less than proportional increase in new enrollees from that state. The positive impact on enrollment may be explained by a decrease in the information gather costs of attending ISU. Clearly a person who has attended ISU can give much better information than other sources. This is especially true if that person is a family member of the student who is choosing to attend college. Increased density of alumni may also be acting to decrease the psychological distance from ISU. In any event, these findings suggest that enlisting the support of alumni in recruiting efforts may be fruitful. If prospective students have contact with alumni and are able to become familiar with the school, they may feel more at ease in making the decision to attend Iowa State.

Demographics, measured by the number of high school graduates, have an ambiguous effect on enrollment. The coefficients are positive for the entire sample, but negative in most of the subsamples. Overall, the OLS results show that the effect of the 20 percent decline in high school graduates since 1976 has reduced nonresident enrollment by at most 8.8 percent.

Family income also plays an important role in determining ISU enrollment. The ability of a family to pay nonresident tuition, or perhaps the lack thereof, greatly influences the decision to attend ISU. In all but one subsample the coefficient is above 1 and is as high as 8. The positive sign of the coefficient indicates that Iowa State education is a "normal good". This implies that increases in per capita incomes in other states lead to increases in nonresident enrollment at ISU. However, the magnitude of some of the results seems to be suspect. The results show that a 1 percent increase in the mean income nationally will lead to an enrollment increase of 1.5 percent at Iowa State.

The coefficient on national annual relative salary shows that there is not a clear effect of an increase in college salaries relative to high school salaries on nonresident enrollment at ISU. The sign of the coefficient is not consistent across samples and the coefficient is often insignificant. Overall, it appears that ISU has not seen any dramatic change in enrollment in response to the increasing returns to college degrees. The results for the entire sample suggest that these increased returns to education have led to declines in ISU enrollments. This is contrary to what theory would suggest, but consistent with earlier findings for the effects of returns to college on national enrollment. The other subsamples have coefficients that are both positive and negative and usually not significant at the 10 percent level.

The cost of attending a university in a student's own state has the hypothesized positive relationship with Iowa State enrollment. As own state universities become more expensive, a student is more likely to choose ISU. The coefficients range from 0.049 to 3.045. The only region in which this does not hold true is the Big 10. The regressions that included the quality measure for higher education show that only two of the coefficients of in-state education costs are not significant. Those coefficients that are significant are positive and range from 1.009 to 3.031. This implies that Iowa State will see increases in nonresident enrollment when competing institutions increase their costs for residents. One important

factor here is the magnitude of the effect. The ISU enrollment increase is only one-tenth of one percent from a one percent increase in the own state costs of attending college nationally. The effects of states relatively closer to ISU may have a larger impact, as shown by the larger coefficients of the subsamples.

The proxy measure of the current economic conditions, the unemployment rate, is shown to positively impact enrollment at ISU. As the unemployment rate increases, theory would suggest, the cost of attending college decreases and, therefore, more students choose to attend. The cost of attending college is decreased when the unemployment rate increases because the rate is acting as a measure of the alternatives available to high school graduates. This is one of three possible interpretations of the unemployment rate discussed by Hoenack and Weiler (1979). All of the coefficients are positive. They range from 0.173 to 2.441. However, only half of the subsamples have coefficients that are significant. Those that are significant range from 0.971 to 2.441. If the United States experiences a 1 percent increase in the current unemployment rate, ISU can expect to see an increase of almost 1 percent in nonresident enrollment.

The two factors that were included to measure the quality of education yield ambiguous results. Public elementary and secondary spending is positive in most of the subsamples, but often insignificant. However, the coefficient is always positive and significant in the entire sample. The results that are significant are both positive and negative. The coefficients for the entire sample range from 0.573 to 0.663. This implies that if per pupil spending for precollege education were to increase across the U.S., ISU could expect nonresident enrollments to increase by nearly half as much as the increase in spending.

The proxy measure for higher education quality was not included in the regressions reported in Tables 3.5 and 3.7. Table 3.4 shows that the coefficients are only significant in two samples. The coefficients are positive in all subsamples, but negative and insignificant for

the entire sample. This impact of higher education quality is expected to be negative on ISU enrollment. As the student's own state improves its own schools, he has less of an incentive to go out of his own state to attend ISU.

The model does a reasonable job in explaining out-of-state enrollment at Iowa State. The variables explain 60 percent of the variation in nonresident enrollment from all states. When concentrating only on the upper midwest, the model explains 77 percent of the variation.

As discussed in Chapter 1, autocorrelation in the data appears to be a problem in some of the subsamples. Only one subsample, the Big 8, indicates that there is not a problem with autocorrelation. The Big 10 subsample is in the inconclusive region of the Durbin Watson test. All other subsamples have Durbin Watson test statistics below the lower bound. The lower and upper values of the Durbin Watson test are 1.335 and 1.765, respectively for n = 100. The lower and upper values for n = 90 are 1.288 and 1.769, respectively.[3] Since the value of the Durbin-Watson test indicates there is autocorrelation among the independent variables, the Cochrane-Orcutt correction is used. Before discussing the results of the Cochrane-Orcutt model, the OLS results that included individual measure of tuition and room-and-board as independent variables are discussed.

OLS Results for Model with Tuition and Room-and-Board

The results of the models considering individual measures of tuition and room-and-board are given in Tables 3.6 and 3.7. Theory would suggest that the coefficients of ISU tuition and room-and-board would be negative. The coefficients for tuition are negative for the subsamples but positive for the entire sample. Only three of the coefficients are significant at the 10 percent level in the specification that includes higher education spending (Table 3.6).

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[3] The critical values of the Durbin Watson test are taken from Greene (1990).

The coefficients range from -0.182 to -1.942. The coefficients are in the elastic and inelastic ranges. Therefore, the impact on tuition revenue of an increase in tuition is not clear.

The coefficients of room-and-board costs at ISU are negative as is predicted by theory. However, they are often insignificant. The coefficients that are negative are in the elastic range, above 1 in absolute value. This shows that an increase in room-and-board will lead to larger than proportional decreases in nonresident enrollment. However, recall that the coefficients are not significant.

The coefficients of tuition and room-and-board in the student's own state are expected to be positive. This is shown to be the case, however, again the coefficients lack significance. The measure of home state resident tuition is positive in most subsamples. Most of the coefficients of the own state tuition are below one in absolute value. This means that a 1 percent increase in the own state tuition will lead to a less than 1 percent increase in nonresident enrollment at ISU. This may be reasonable since students are very likely considering more options than just the choice between an institution in their own state and ISU. They may choose to attend another institution that would not be measured by the current research.

The other coefficients show similar results to the regressions that included total costs rather than the two measures separately. The most notable change is the lack of significance of many of the coefficients. The statistics about the performance of the model are much the same. The R-Squared values are very close and the Durbin-Watson values imply that there is still a problem with autocorrelation.

The use of total costs instead of tuition and room-and-board, statistically is a test of the equality of the coefficients for tuition and room-and-board. This would involve testing the null hypothesis :

$$H_0: \beta_{tui} = \beta_{rmbrd}$$
$$vs. \qquad (3.10)$$
$$H_A: \beta_{tui} \neq \beta_{rmbrd}$$

The test for this restriction is an F-test. The test statistic is 4.568 for the entire sample, where the regression included the higher education measure, lnlsub.[4] The critical F value is 6.63 at the 99 percent confidence level.[5] The hypothesis cannot be rejected. Therefore, the restriction on the coefficients is reasonable.

Results for Cochrane - Orcutt Model

The Cochrane-Orcutt correction for autocorrelation is discussed in Chapter 2. The correction is used to adjust for correlation in the error terms across time. The results of the procedure are given in Tables 3.8 and 3.9. The correction process was only applied to the regression using the total cost measure. As discussed earlier, the total cost measure gives results that are significant and consistent with theory across the samples examined in this study. The same independent variables are used in this procedure. As above, the coefficients represent elasticities.

The coefficient of total cost of ISU education is hypothesized to be negative, and was negative under the OLS regression. In the corrected model the coefficient of ISU costs is negative across all specifications and all subsamples. The elasticity across all states was -1.272 and significant. Three of the samples have significant coefficients in the model that includes the measure for higher education quality. The results in Table 3.8 are consistent with the results found in the OLS model. An increase in the cost of attending ISU will lead to a more than proportional decrease in nonresident enrollment at ISU. The second model in Table 3.9, which does not consider the measure for higher education spending, also has negative coefficients for the cost of attending Iowa State University. Once again, the overall

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[4] The values used in computing the F-statistic are :SSE (restricted) = 1373.19, SSE (unrestricted) = 1366.02, n=882, number of coefficients = 12.

[5] $F(1, 870, 99\%) \approx F(1, \infty, 99\%) = 6.63$, Greene (1990).

elasticity is greater than one in absolute value and significant. The coefficients appear to be consistent across both the Cochrane-Orcutt and OLS models.

This model also shows that as the number of high school graduates increase ISU enrollment will also increase. These results are more consistent than the OLS results. Now the Big 8 sample provides the only exception. This subsample has a negative coefficient of high school graduates. The coefficient on high school graduates over the entire sample is 0.545. This implies that the 20 percent reduction in the size of high school graduating classes has lead to an 11 percent reduction in nonresident enrollments at ISU. When smaller samples are considered, the response moves from being less than proportional to greater than proportional. The subsamples that have significant coefficients range from 1.272 to 2.280. This implies that in some regions adjacent to Iowa, an increase of 1 percent in high school graduates will lead to nonresident enrollment increasing by 1.27 to 2.28 percent.

The variable of distance remained negative across all the subsamples. It is above one, in absolute value for all cases except the Big 8 sample in Table 3.8. The coefficients indicate that a 1 percent increase in the distance from ISU will cause a 0.9 to 2.699 percent decline in the number of nonresidents enrolling at Iowa State. This is consistent with the previous OLS results.

The subsamples of the Big 8 and Big 10 combined, the upper midwest region, and the border states have very few coefficients that are significant. The coefficient of correlation, rho, is positive and significant across all samples. This indicates that the model does have a problem with autocorrelation; however, the corrected model as a whole performs reasonably well. The R-Squared values range from a low of 0.6599 to 0.9580. This leaves a small amount of variation in ISU nonresident enrollment that is not explained by the independent variables.

Revenue Changes from Cost Adjustments

One of the main emphasis of this chapter is to determine what policies ISU needs to take to increase revenues from tuition. Both of the models show that the elasticity of nonresident enrollment with respect to the cost of attending ISU ranges from -1 to -4. In each case the elasticity is in the elastic range. This implies that revenues can be increased by lowering the cost of attending ISU. The question that a policy maker would now ask is what amount of decrease in tuition costs will maximize revenues.

Suppose that a proposed percentage reduction in the cost of attending ISU is X. Let T be current tuition and other direct costs, and let current enrollment be N. The change in enrollment from a change in T is determined by the elasticity η, where η is <0. Then revenue from tuition would be R, where

$$R = (1 - X)T \cdot N(1 - \eta X) \tag{3.10}$$

When X=0, R = TN or current tuition times current enrollment. As X is increased above zero, tuition falls to (1-X)T and enrollment rises to N(1-ηX). Simplifying (3.10), revenue can be written as

$$R = TN(1 - X - \eta X + \eta X^2). \tag{3.11}$$

Then maximizing (3.11) with respect to X, the reduction in cost of attending ISU, gives the following result.

$$\frac{dR}{dX} = TN(-1 - \eta + 2\eta X) = 0 \tag{3.12}$$

Finally, solving for X in (3.12), the optimum proportional reduction in tuition is

$$X = \frac{\eta + 1}{2\eta}. \tag{3.13}$$

Provided $\eta<-1$, X will be positive. When $\eta=-1$, X is zero, and when $\eta>-1$, the optimum strategy is to raise tuition.

Suppose, as an example, we assume that the correct price elasticity is the upper midwest measure from Table 3.4. This shows the elasticity is -1.961. This implies that

revenues would be maximized if the cost of attending ISU were decreased by 24.5 percent. This result seems to be very important for policy makers at ISU. By decreasing the cost of attending ISU, the University will realize an increase in enrollment and an increase in tuition revenues. Note that the reduction not only helps students attend college, but it is also beneficial for the University. Suppose, for example, that costs for nonresidents are near $4000, and that there are 1000 nonresident students. A 25 percent reduction in tuition will lead to an increase of 490 nonresident students. Before the decrease in tuition, the revenue from nonresidents was 4 million dollars. After the reduction, the tuition revenue per student is $3000. The revenue from nonresidents is 4.471 million dollars. Revenue is increased by almost one half of one million dollars. Over the long run, this type of policy will increase enrollments even more. Assuming an annual attrition rate of 0.157, nonresident enrollment will rise to 2545. Nonresident tuition revenues will be 7.63 million dollars, almost doubling the nonresident tuition before the policy change. Admittedly, the above estimates are undoubtedly high since the estimate of η refers to the upper midwest region and not the overall sample.

A more conservative estimate of η is the coefficient -1.272 from Table 3.8. A similar exercise would suggest that revenues would be maximized by lowering tuition by 10.7 percent. Using the same starting points as before, reducing tuition from $4000 to $3572 would increase nonresident enrollment to 1136. Thus total nonresident tuition would rise from $4 million to $4.058 million. Assuming the same attrition rate as before, long run nonresident enrollment would increase to 1429 within four years. Then revenues from tuition would increase to $5.1 million per year, or over $1 million in increased revenues annually.

Perhaps now it is clear why it is important for policy makers at Iowa State to be informed of the impact of their tuition decisions. There are many other policy implications

from the results of the two studies. These implications of both the ISU study and the national study, discussed in Chapter 2, will be discussed in the final chapter.

Table 3.1 Brief definitions of variable names.

Variable	Definition
Dependent Variable:	
isuenr	Iowa State University new fall enrollees in the own state
Independent Variables:	
lnincp	real income per capita in the own state
lnisut	real Iowa State University annual nonresident tuition
lnisurb	real Iowa State University annual room-and-board
lnisucost	real total cost of attending Iowa State: the sum of nonresident tuition and room-and-board
lninst	real annual tuition and fees at public institutions in the own state
lnrmbrd	real annual room-and-board at public institutions in the own state
lnincost	real total cost of attending an own state 4-year college: the sum of resident tuition and room-and-board
lnpexp	real current fund expenditures per pupil in average daily attendance at public elementary and secondary school in own state
lnalumni	the number of Iowa State alumni living in each state
lnhsgrad	the number of high school graduates in each state
lnlsub	real local subsidization of higher education: a proxy measure for quality
lndist	the distance from Iowa State University to the closest border of the own state
lnrelsal	the ratio of college salary over high school salary
lnunempl	the unemployment rate of 18-19 year olds

Table 3.2 Mean and standard deviation of the natural log of the variables used in the analysis.

Variable	49 States	Big 8	Big 10	Big 8 & 10	U M W	Border
lnisuenr	1.271	2.585	3.716	3.202	2.815	4.408
	(1.970)	(1.538)	(1.535)	(1.633)	(1.647)	(1.037)
lnincp	4.762	4.779	4.818	4.801	4.768	4.778
	(0.166)	(0.091)	(0.091)	(0.903)	(0.111)	(0.117)
lnisut	3.468	3.468	3.468	3.468	3.468	3.468
	(0.230)	(0.230)	(0.230)	(0.229)	(0.229)	(0.230)
lnisurb	2.954	2.954	2.954	2.954	2.954	2.954
	(0.071)	(0.071)	(0.071)	(0.071)	(0.071)	(0.071)
lnisuc	3.942	3.942	3.942	3.942	3.942	3.942
	(0.163)	(0.163)	(0.163)	(0.163)	(0.163)	(0.163)
lninst	2.408	2.307	2.688	2.515	2.481	2.494
	(0.395)	(0.234)	(0.222)	(0.296)	(0.280)	(0.225)
lnrmbrd	3.240	3.112	3.272	3.199	3.184	3.126
	(0.208)	(0.179)	(0.174)	(0.193)	(0.196)	(0.209)
lnincost	3.618	3.491	3.721	3.616	3.595	3.562
	(0.208)	(0.142)	(0.158)	(0.189)	(0.179)	(0.158)
lnpexp	3.382	3.345	3.451	3.403	3.393	3.398
	(0.262)	(0.156)	(0.158)	(0.165)	(0.190)	(0.166)
lnalumni	6.514	7.123	7.708	7.442	7.032	7.403
	(1.168)	(0.730)	(0.974)	(0.917)	(1.081)	(1.230)
lnhsgrad	10.420	10.431	11.416	10.968	10.470	10.652
	(0.993)	(0.346)	(0.365)	(0.607)	(0.995)	(0.859)
lnlsub	-3.425	-3.541	-2.741	-3.105	-3.507	-3.336
	(0.906)	(0.251)	(0.450)	(0.546)	(0.876)	(0.857)
lndist	1.623	0.730	0.524	0.618	0.770	
	(0.752)	(0.532)	(0.599)	(0.577)	(0.608)	
lnrelsal	0.504	0.504	0.504	0.504	0.504	0.504
	(0.068)	(0.068)	(0.068)	(0.068)	(0.068)	(0.068)
lnunempl	2.782	2.782	2.782	2.782	2.782	2.782
	(0.153)	(0.153)	(0.153)	(0.153)	(0.153)	(0.153)

( ) Standard Deviation

Table 3.3. The percent of Iowa State University nonresident enrollment from the states with the largest portions of ISU nonresidents, 1973-1992.

Year	Illinois	Minnesota	Nebraska	South Dakota	Wisconsin	Missouri
1973	34.33	11.65	5.05	3.71	6.80	3.81
1974	36.98	13.92	6.27	1.81	6.06	3.08
1975	36.48	10.62	8.37	4.18	5.58	3.33
1976	38.45	12.29	7.63	3.87	5.45	2.68
1977	36.02	12.97	10.28	3.94	6.05	2.50
1978	39.49	12.22	9.87	4.89	5.47	3.42
1979	36.95	12.58	10.67	4.16	4.94	2.25
1980	44.99	14.91	9.36	2.57	4.23	2.32
1981	46.73	14.95	10.52	2.55	3.98	2.78
1982	49.83	12.84	10.84	1.17	4.35	2.83
1983	53.89	12.81	10.18	1.19	2.95	2.89
1984	57.13	11.72	8.41	2.00	3.86	2.55
1985	51.97	15.07	10.02	2.14	2.91	3.17
1986	50.61	15.00	11.05	2.46	3.60	2.19
1987	51.04	14.94	9.10	1.78	3.46	2.67
1988	51.93	12.66	7.08	2.68	3.76	2.68
1989	49.64	14.39	9.35	1.95	3.29	3.91
1990	41.03	20.75	10.67	2.58	3.28	2.81
1991	38.34	17.85	10.24	1.93	4.16	3.45
1992	38.35	19.18	11.79	1.68	4.12	2.99

Source: *Iowa State University Enrollment Services Annual Statistical Report.*

Table 3.4. OLS results for the model with total cost measures and local subsidy.

	49 States	Big 8	Big 10	B 8&10	U M W	Border
Intercept	-20.167 ***	11.459	-29.101 ***	-14.198 **	-1.536	-31.349 ***
	(3.307)	(9.304)	(4.815)	(6.769)	(4.872)	(5.836)
lnincp	3.882 ***	2.869	2.692 **	5.997 ***	1.582 **	8.177 ***
	(0.496)	(2.287)	(1.222)	(1.386)	(0.784)	(1.117)
lnisuc	-1.003 *	-4.207 ***	-0.120	-2.783 ***	-1.961 ***	-2.855 ***
	(0.551)	(1.119)	(0.632)	(0.824)	(0.709)	(0.688)
lninstcost	0.049	3.031 ***	-0.427	1.224 ***	1.208 **	1.009 *
	(0.270)	(0.910)	(0.492)	(0.603)	(0.536)	(0.598)
lnpexp	0.595 ***	1.297	-2.296 ***	-0.726	0.003	0.544
	(0.312)	(1.476)	(0.452)	(0.743)	(0.438)	(0.591)
lnalumni	0.341 ***	-0.030	0.135 **	0.378 ***	0.433 ***	0.287 ***
	(0.052)	(0.149)	(0.054)	(0.082)	(0.066)	(0.054)
lnhsgrad	0.424 ***	-0.163	2.459 ***	-0.479 ***	-0.254	-0.432 ***
	(0.092)	(0.312)	(0.237)	(0.177)	(0.156)	(0.120)
lnlsub	-0.090	5.337 ***	0.095	0.805 ***	0.161	0.093
	(0.097)	(0.782)	(0.115)	(0.189)	(0.144)	(0.123)
lnrels	-5.593 ***	-9.075 ***	3.982 ***	-0.689	1.978	-2.323
	(1.169)	(3.352)	(1.369)	(1.968)	(1.592)	(1.856)
lndist	-1.302 ***	-0.914 ***	-2.881 ***	-1.859 ***	-1.909 ***	
	(0.067)	(0.238)	(0.136)	(0.117)	(0.107)	
lnunempl	0.971 **	1.847 **	0.173	1.459	0.301	2.319 ***
	(0.433)	(0.905)	(0.467)	(0.624)	(0.512)	(0.543)
R-Square	0.5986	0.7669	0.9461	0.7508	0.7721	0.8067
F Value	129.884	25.997	170.283	56.336	87.787	45.437
D. W.	1.24733	1.93734	1.70303	0.93166	0.77914	0.90413
n	882	90	108	198	270	108

\# Log (enrollment + 0.1) used here
( ) Standard Error
* Significant at 1 % level
** Significant at 5 % level
*** Significant at 10 % level

Table 3.5. OLS results for the model with total costs, without local subsidy.

	49 States	Big 8	Big 10	B 8&10	U M W	Border
Intercept	-18.951 ***	12.963	-30.975 ***	-25.289 ***	-4.335	-34.102 ***
	(3.036)	(11.651)	(4.235)	(6.523)	(4.182)	(4.528)
lnincp	3.905 ***	-3.068	2.832 **	5.360 ***	1.580 **	8.436 ***
	(0.495)	(2.650)	(1.208)	(1.439)	(0.785)	(1.060)
lnisuc	-1.092 **	-2.734 **	-0.0004	-2.372 ***	-1.780 **	-2.776 ***
	(0.543)	(1.375)	(0.614)	(0.855)	(0.690)	(0.679)
lnincost	0.107	3.045 ***	-0.524	1.424 **	1.086 **	0.905
	(0.262)	(1.141)	(0.477)	(0.628)	(0.525)	(0.581)
lnpexp	0.573 *	4.746 ***	-2.202 ***	0.453	0.128	0.747
	(0.311)	(1.737)	(0.437)	(0.720)	(0.423)	(0.524)
lnalumni	0.333 ***	0.037	0.129 **	0.334 ***	0.424 ***	0.282 ***
	(0.051)	(0.187)	(0.054)	(0.085)	(0.065)	(0.054)
lnhsgrad	0.356 ***	-1.128 ***	2.497 ***	-0.047	-0.109	-0.386 ***
	(0.057)	(0.349)	(0.232)	(0.152)	(0.086)	(0.104)
lnrels	-5.675 ***	0.721	3.813 ***	0.236	2.014	-2.743
	(1.165)	(3.794)	(1.351)	(2.042)	(1.592)	(1.766)
lndist	-1.318 ***	-2.085 ***	-2.858 ***	-1.914 ***	-1.903 ***	
	(0.064)	(0.207)	(0.133)	(0.122)	(0.106)	
lnunempl	0.977 ***	0.437	0.243	1.624 **	0.326	2.441 ***
	(0.433)	(1.103)	(0.458)	(0.669)	(0.512)	(0.517)
R-Square	0.5982	0.6297	0.9457	0.7267	0.7710	0.8056
F Value	144.243	15.115	189.755	55.549	97.276	51.273
D. W.	1.24719	1.12014	1.66735	0.76260	0.76183	0.88993
n	882	90	108	198	270	108

( ) Standard Error
* Significant at 1 % level
** Significant at 5 % level
*** Significant at 10 % level

Table 3.6. OLS results for the model with tuition and room-and-board and local subsidy.

	49 State	Big 8	Big 10	B 8&10	U M W	Border
Intercept	-14.672 ***	13.364	-29.810 ***	-14.436 *	1.237	-30.139 ***
	(4.321)	(10.648)	(5.527)	(7.705)	(5.591)	(6.530)
lnincp	3.922 ***	3.003	2.408 *	6.017 ***	1.549 **	8.347 ***
	(0.496)	(2.301)	(1.290)	(1.390)	(0.777)	(1.157)
lninst	0.074	1.014	0.024	0.619 **	0.915 ***	0.284
	(0.127)	(0.527)	(0.312)	(0.289)	(0.245)	(0.308)
lnisut	0.321	-1.942 *	-0.383	-1.557 *	-0.917	-1.194 *
	(0.561)	(1.198)	(0.599)	(0.854)	(0.697)	(0.687)
lnisurb	-2.871 **	-3.157	0.653	-1.209	-1.609	-2.590 *
	(1.278)	(2.669)	(1.145)	(1.853)	(1.474)	(1.454)
lnrmbrd	-0.278	1.746 *	-0.374	0.241	-0.086	0.632
	(0.304)	(0.885)	(0.455)	(0.647)	(0.480)	(0.520)
lnpexp	0.663 **	1.311	-2.313 ***	-0.708	0.388	0.608
	(0.313)	(1.527)	(0.463)	(0.757)	(0.453)	(0.648)
lnalumni	0.347 ***	0.0000	0.129 **	0.389 ***	0.415 ***	0.292 ***
	(0.052)	(0.151)	(0.055)	(0.082)	(0.065)	(0.054)
lnhsgrad	0.444 ***	-0.040	2.504 ***	-0.420 **	-0.245	-0.427 ***
	(0.093)	(0.366)	(0.252)	(0.183)	(0.155)	(0.141)
lnlsub	-0.099	5.427 ***	0.137	0.764 ***	0.172	0.065
	(0.097)	(0.794)	(0.128)	(0.194)	(0.143)	(0.127)
lnrels	-8.528 ***	-11.849 **	4.665 **	-2.162	-0.942	-4.053
	(1.707)	(4.686)	(1.942)	(2.985)	(2.285)	(2.583)
lndist	-1.267 ***	-0.890 ***	-2.936 ***	-1.835 ***	-1.815 ***	
	(0.074)	(0.250)	(0.154)	(0.121)	(0.111)	
lnunempl	0.803 *	1.808 *	0.161	1.481 **	0.338	2.282 ***
	(0.440)	(0.920)	(0.481)	(0.650)	(0.512)	(0.557)
R-Squared	0.6007	0.7684	0.9464	0.7521	0.7803	0.8101
F value	108.935	21.286	139.845	46.780	76.054	37.229
D.W.	1.24781	1.94987	1.73470	0.92604	0.78834	0.89451
n	882	90	108	198	270	108

( ) Standard Error
* Significant at 1 % level
** Significant at 5 % level
*** Significant at 10 % level

Table 3.7. OLS results for the model with tuition and room-and-board, without local subsidy.

	49 State	Big 8	Big 10	B 8&10	U M W	Border
Intercept	-13.428 ***	14.428	-32.272 ***	-22.123 ***	-1.304	-31.825 ***
	(4.146)	(13.408)	(5.032)	(7.739)	(5.184)	(5.595)
lnincp	3.49 ***	-2.892	2.740 **	5.444 ***	1.551 **	8.552 ***
	(0.495)	(2.686)	(1.253)	(1.436)	(0.777)	(1.079)
lninst	0.095	1.221 **	-0.127	0.821 ***	0.863 ***	0.242
	(0.125)	(0.662)	(0.278)	(0.296)	(0.241)	(0.295)
lnisut	0.249	-1.068	-0.182	-0.999	-0.734	-1.109 *
	0.557)	(1.500)	(0.569)	(0.875)	(0.681)	(0.664)
lnisurb	-2.881 **	-2.160	0.474	-1.828	-1.716	-2.731 *
	(1.278)	(3.356)	(1.134)	(1.917)	(1.472)	(1.422)
lnrmbrd	-0.233	1.266	-0.340	-0.011	-0.163	0.604
	(0.301)	(1.112)	(0.455)	(0.668)	(0.476)	(0.515)
lnpexp	0.637 **	4.674 **	-2.205 ***	0.430	0.518	0.772
	(0.312)	(1.820)	(0.452)	(0.727)	(0.440)	(0.559)
lnalumni	0.339 ***	0.091	0.123 **	0.354 ***	0.406 ***	0.290 ***
	(0.051)	(0.189)	(0.055)	(0.852)	(0.064)	(0.053)
lnhsgrad	0.369 ***	-0.907 **	2.514 ***	0.010	-0.090	-0.404 ***
	(0.057)	(0.432)	(0.252)	(0.152)	(0.869)	(0.132)
lnrels	-8.599 ***	-2.456	4.322 **	-2.788	-1.032	-4.476 *
	(1.706)	(5.642)	(1.917)	(3.095)	(2.286)	(2.435)
lndist	-1.283 ***	-2.028 ***	-2.877 ***	-1.866 ***	-1.809 ***	
	(0.072)	(0.235)	(0.145)	(0.126)	(0.111)	
lnunempl	0.814 *	0.433	0.273	1.572 **	0.347	2.365 ***
	(0.440)	(1.130)	(0.470)	(0.675)	(0.512)	(0.530)
R-Squared	0.6002	0.6279	0.9458	0.7313	0.7790	0.8096
F value	118.738	11.964	152.212	46.030	82.690	41.243
D.W.	1.24747	1.10325	1.67719	0.76581	0.76822	0.88753
n	882	90	108	198	253	108

( ) Standard Error
* Significant at 1 % level
** Significant at 5 % level
*** Significant at 10 % level

Table 3.8. Cochrane - Orcutt results for the model with total costs and local subsidy.

	49 States	Big 8	Big 10	Big 8 & 10	U M W	Border
intercept	-12.646 ***	9.651	-23.771 ***	-6.849 **	-1.362	-0.149
	(2.559)	(8.914)	(5.849)	(2.869)	(1.632)	(0.316)
lnincp	4.105 ***	3.523	4.534 ***	5.817 ***	1.652	1.522**
	(0.735)	(2.560)	(1.645)	(1.774)	(1.046)	(0.620)
lnisuc	-1.272 **	-3.602 ***	-0.240	-1.500 *	-0.385	-0.224
	(0.614)	(1.160)	(0.750)	(0.860)	(0.720)	(0.580)
lninstc	-0.200	2.611 **	-0.767	0.315	0.215	-1.079
	(0.436)	(1.149)	(0.749)	(1.345)	(1.160)	(0.895)
lnpexp	0.603	0.074	-1.826 ***	0.258	-0.405	0.081
	(0.461)	(1.794)	(0.670)	(1.046)	(0.688)	(0.511)
lnalum	0.218 ***	0.062	0.101	0.088	0.076	-0.012
	(0.068)	(0.163)	(0.072)	(0.099)	(0.086)	(0.038)
lnhsgrd	0.545 ***	-0.193	2.270 ***	0.151	0.207	1.284
	(0.137)	(0.357)	(0.333)	(0.381)	(0.269)	(0.853)
lnlsub	-0.154	5.316 ***	0.032	0.109	-0.076	-0.001
	(0.136)	(0.864)	(0.137)	(0.206)	(0.188)	(0.071)
lnrelsal	-3.822 ***	-7.576 **	1.747	-1.755	0.785	0.957
	(1.344)	(3.547)	(1.618)	(1.819)	(1.495)	(1.088)
lnunempl	1.183 **	1.714 *	0.759	1.484 **	0.236	0.172
	(0.494)	(0.981)	(0.618)	(0.643)	(0.502)	(0.301)
lndist	-1.402 ***	-0.926 ***	-2.699 ***	-1.903 ***	-2.002 ***	
	(0.107)	(0.258)	(0.212)	(0.317)	(0.293)	
rho	0.408 ***	0.103	0.344 ***	0.724 ***	0.747 ***	0.990***
	(0.033)	(0.129)	(0.124)	(0.058)	(0.047)	(0.025)
n	784	80	96	176	240	96
R-Squared	0.6604	0.7813	0.9471	0.8551	0.8723	0.9578
MSE	1.34948	0.55413	0.14247	0.39863	0.36947	0.05174

( ) Standard Error
* Significant at 1 % level
** Significant at 5 % level
*** Significant at 10 % level

Table 3.9. Cochrane - Orcutt results for the model with total costs, without local subsidy

	49 States	Big 8	Big 10	Big 8 & 10	U M W	Border
Intercept	-11.447 ***	-3.427	-24.053***	-6.973 **	-1.078	-0.148
	(2.309)	(6.674)	(5.696)	(2.807)	(1.450)	(0.314)
lnincp	4.113 ***	4.156	4.575 ***	5.741 ***	1.652	1.521**
	(0.733)	(3.114)	(1.631)	(1.771)	(1.043)	(0.616)
lnisuc	-1.397 **	-1.845	-0.208	-1.427 *	-0.437	-0.226
	(0.604)	(1.461)	(0.733)	(0.854)	(0.707)	(0.570)
lninstc	-0.097	2.018	-0.810	0.241	0.281	-1.076
	(0.425)	(1.970)	(0.725)	(1.363)	(1.146)	(0.880)
lnpexp	0.572	0.914	-1.783 ***	0.372	-0.454	0.079
	(0.460)	(2.059)	(0.646)	(1.026)	(0.675)	(0.497)
lnalumni	0.209 ***	0.024	0.100	0.085	0.077	-0.012
	(0.067)	(0.204)	(0.071)	(0.099)	(0.086)	(0.037)
lnhsgrad	0.426 ***	-1.272 *	2.280 ***	0.223	0.141	1.286
	(0.087)	(0.701)	(0.328)	(0.368)	(0.215)	(0.847)
lnrelsal	-3.971 ***	-0.386	1.700	-1.637	0.689	0.957
	(1.337)	(3.617)	(1.600)	(1.801)	(1.474)	(1.081)
lnunempl	1.201 **	0.961	0.789	1.485 **	0.236	0.171
	(0.494)	(1.175)	(0.603)	(0.641)	(0.501)	(0.298)
lndist	-1.426 ***	-2.008 ***	-2.687 ***	-1.907 ***	-2.005 ***	
	(0.104)	(0.450)	(0.206)	(0.326)	(0.291)	
rho	0.406 ***	0.591 ***	0.346 ***	0.732 ***	0.746 ***	0.990***
	(0.033)	(0.099)	(0.123)	(0.057)	(0.047)	(0.025)
n	784	80	96	176	240	96
R-Squared	0.6599	0.7287	0.9470	0.8549	0.8722	0.9578
MSE	1.34997	0.67743	0.14089	0.39685	0.36812	0.05114

( ) Standard Error
* Significant at 1 % level
** Significant at 5 % level
*** Significant at 10 % level

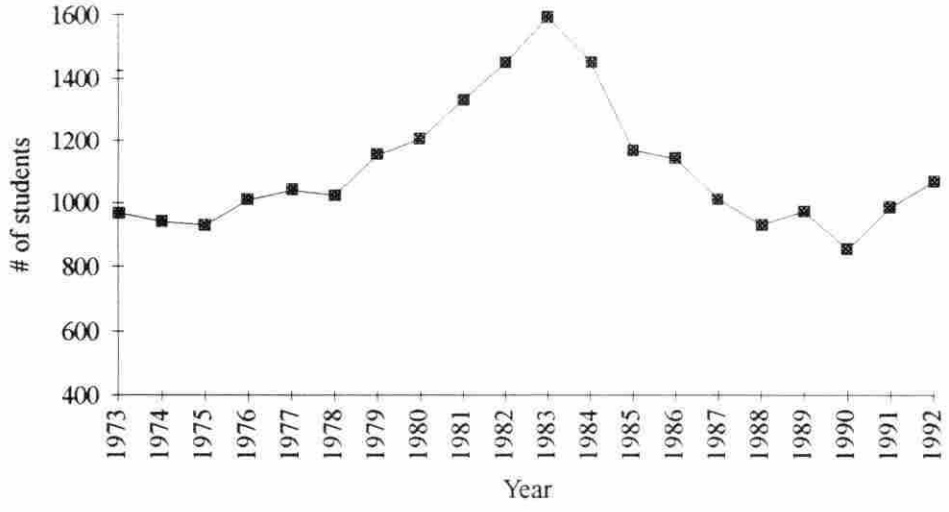

Figure 3.1. Iowa State University new fall nonresident enrollment, 1973 - 1992.
Source: *Iowa State University Enrollment Services Annual Statistical Report.*

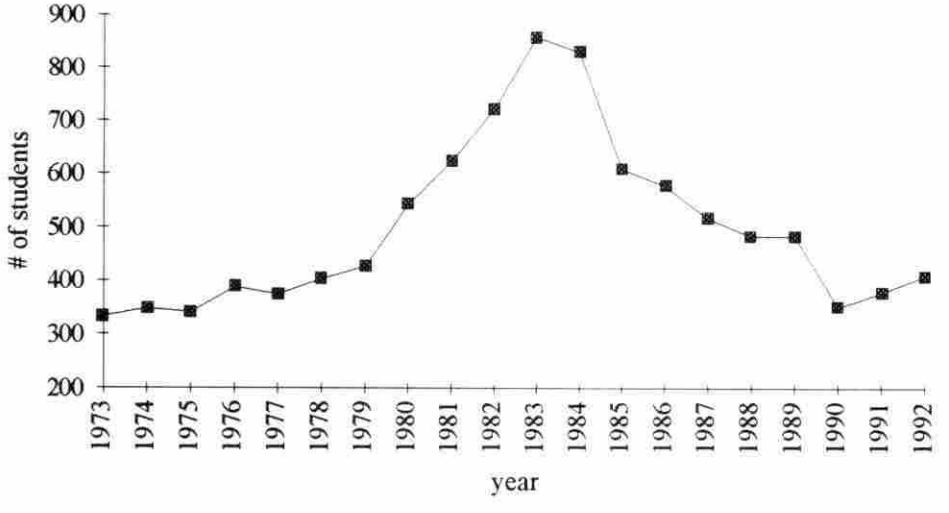

Figure 3.2. Iowa State University new fall enrollment from Illinois, 1973 - 1992.
Source: *Iowa State University Enrollment Services Annual Statistical Report.*

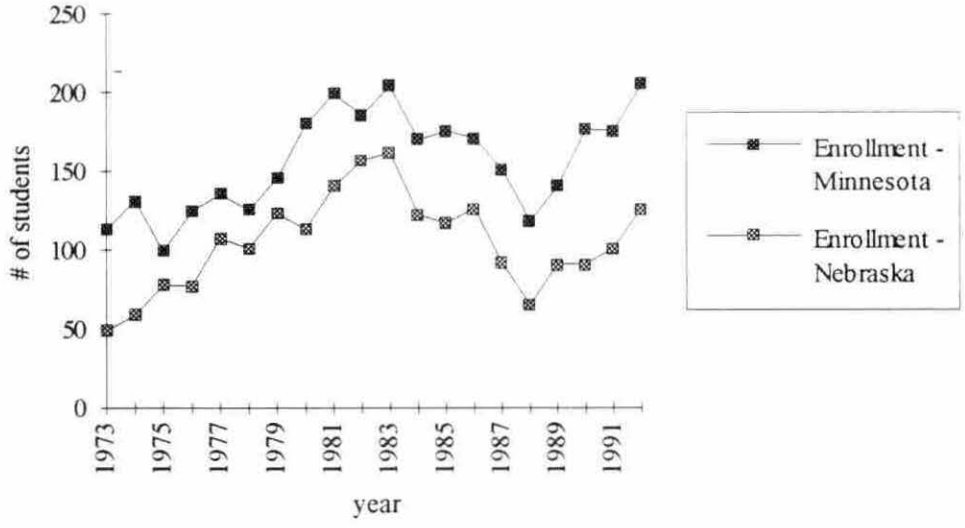

Figure 3.3. Iowa State University new fall enrollment from Minnesota and Nebraska, 1973-1992.
Source: *Iowa State University Enrollment Services Annual Statistical Report.*

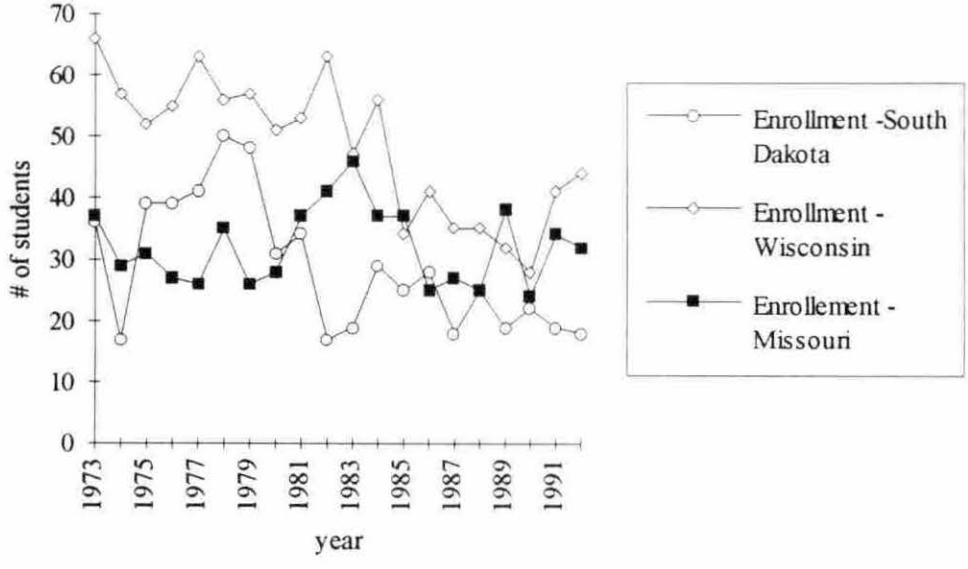

Figure 3.4. Iowa State University new fall enrollment from South Dakota, Wisconsin and Missouri, 1973-1992.
Source: *Iowa State University Enrollment Services Annual Statistical Report.*

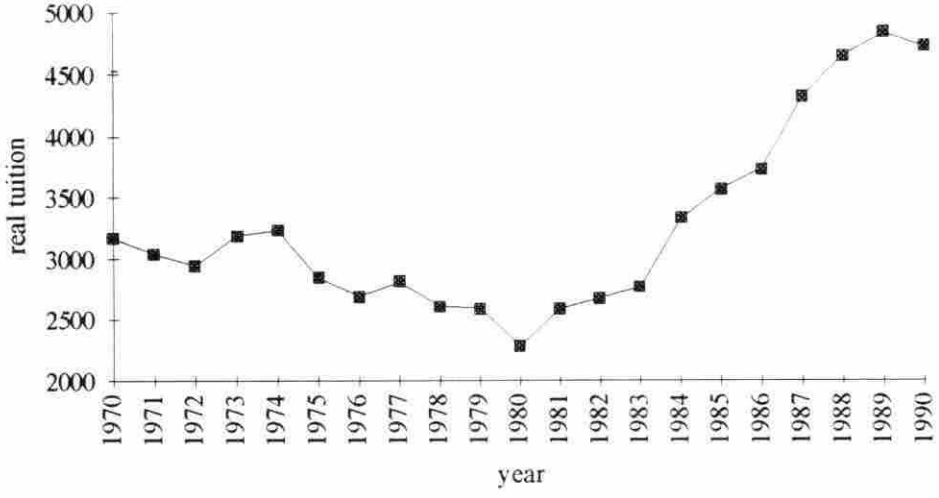

Figure 3.5. Real nonresident tuition at Iowa State University, 1970 - 1990 (1987 dollars).
Source: *Iowa State University Enrollment Services Annual Statistical Report*.

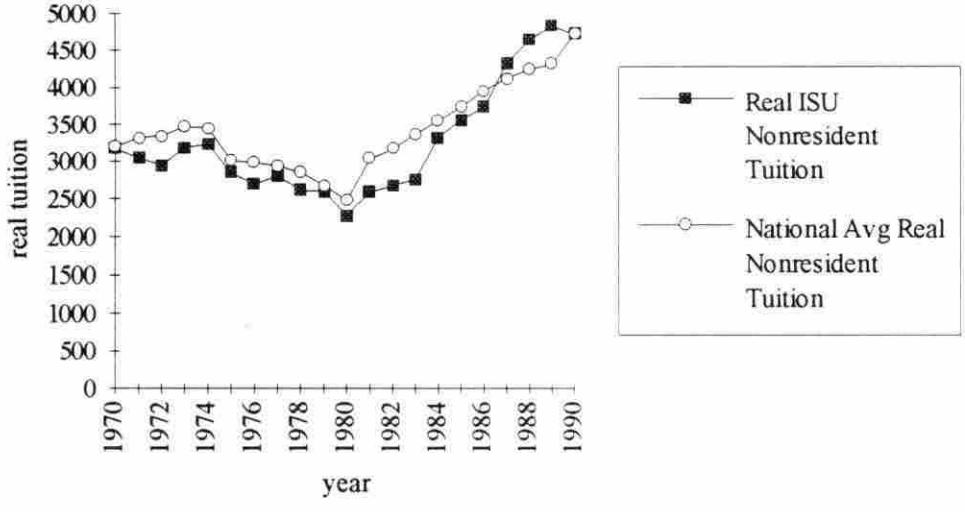

Figure 3.6. Real Iowa State University nonresident tuition and national average real nonresident tuition, 1970 - 1990 (1987 dollars).
Sources: *Iowa State University Enrollment Services Annual Statistical Report*, *Digest of Educational Statistics*.

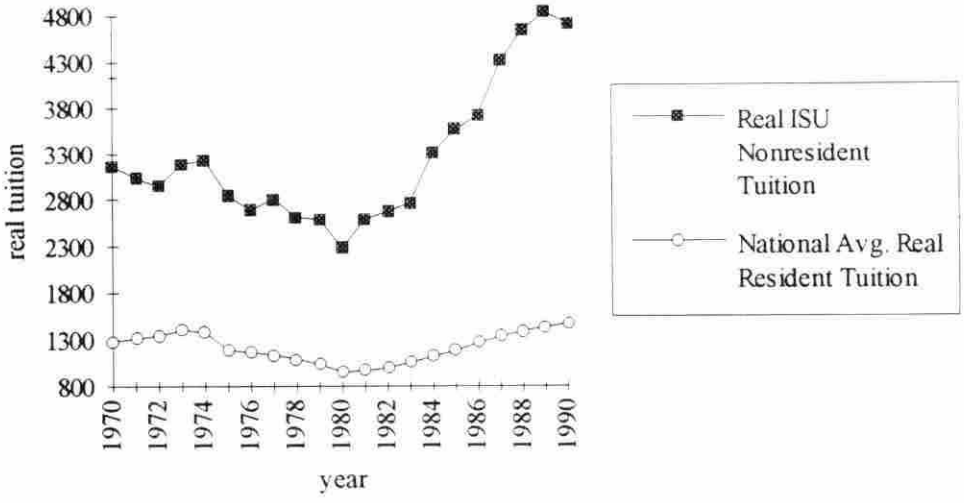

Figure 3.7 Real Iowa State University nonresident tuition and the national average of real resident tuition, 1970 - 1990 (1987 dollars).
Sources: *Iowa State University Enrollment Services Annual Statistical Report, Digest of Education Statistics.*

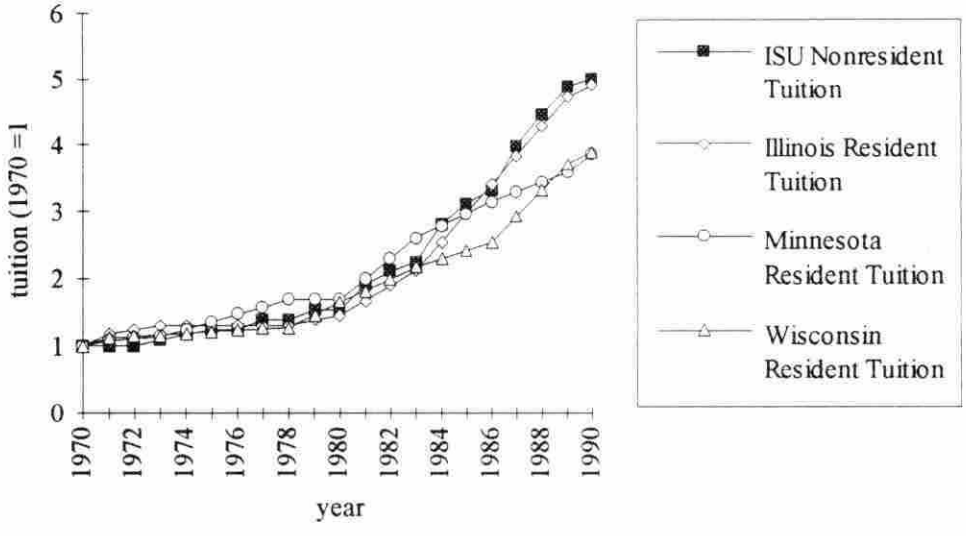

Figure 3.8. Tuition for nonresidents at Iowa State University and residents in Illinois, Minnesota and Wisconsin, relative to 1970, 1970 - 1990.
Nominal 1970 tuition values are 1230, 503, 577, 589, respectively.
Sources: *ISU Enrollment Services Annual Statistical Report, Digest of Educational Statistics, Barrons Profiles of American Colleges, The College Blue Book.*

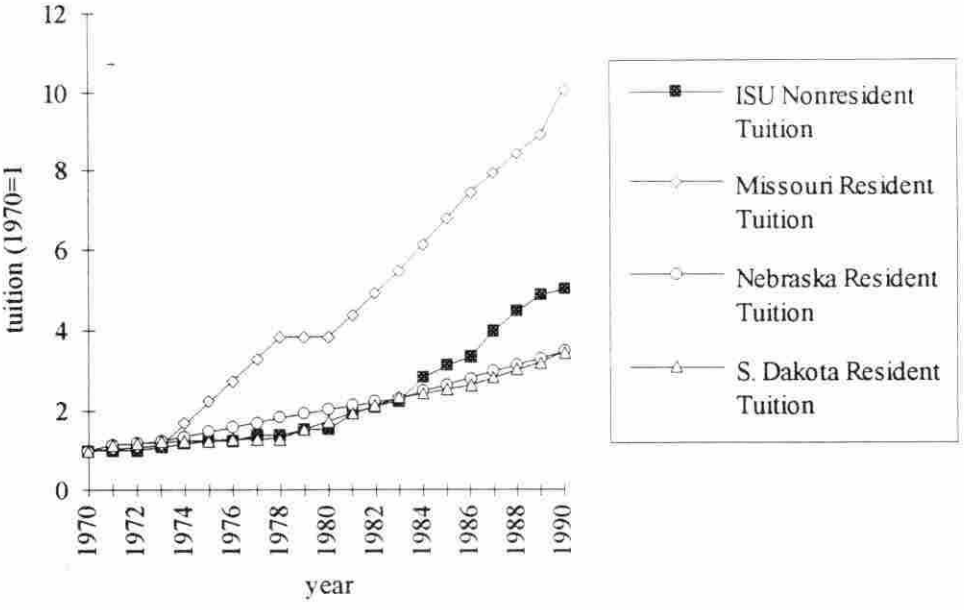

Figure 3.9. Tuition for nonresidents at Iowa State University and residents in Missouri, Nebraska and South Dakota, relative to 1970, 1970 - 1990. Nominal 1970 tuition values are 1230, 172, 461 and 538, respectively. Sources: *ISU Enrollment Services Annual Statistical Report*, *Digest of Educational Statistics*, *Barrons Profiles of American Colleges*, *The College Blue Book*.

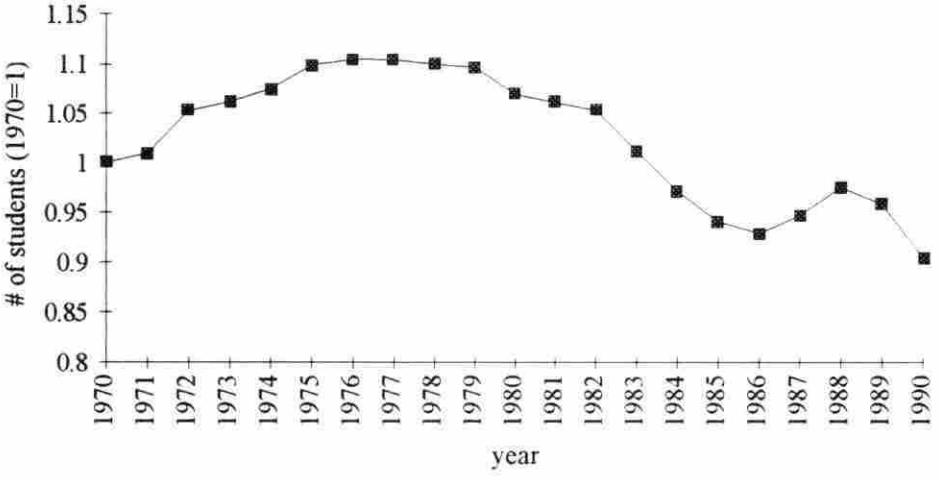

Figure 3.10. Index of U.S. high school graduates, 1970 - 1990 (1970=1). Source: *Digest of Educational Statistics*.

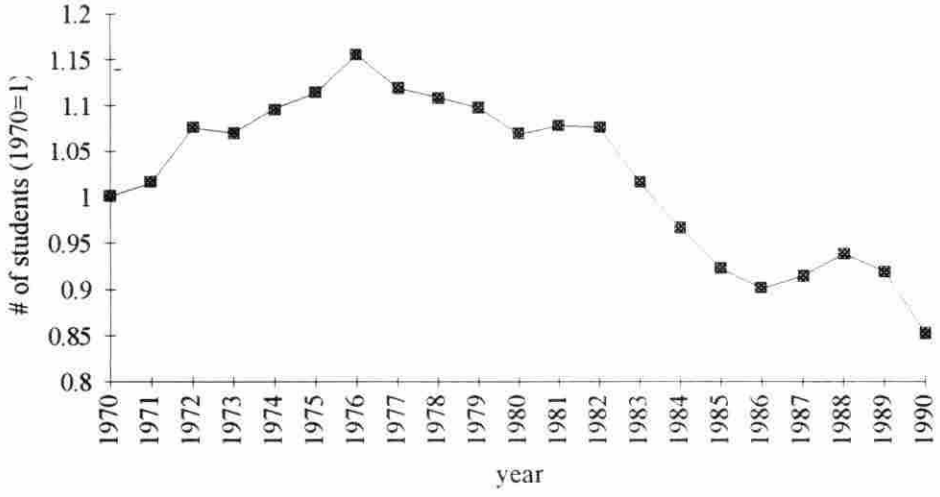

Figure 3.11. Index of Illinois high school graduates, 1970 - 1990 (1970 = 1).
Source: *Digest of Educational Statistics*.

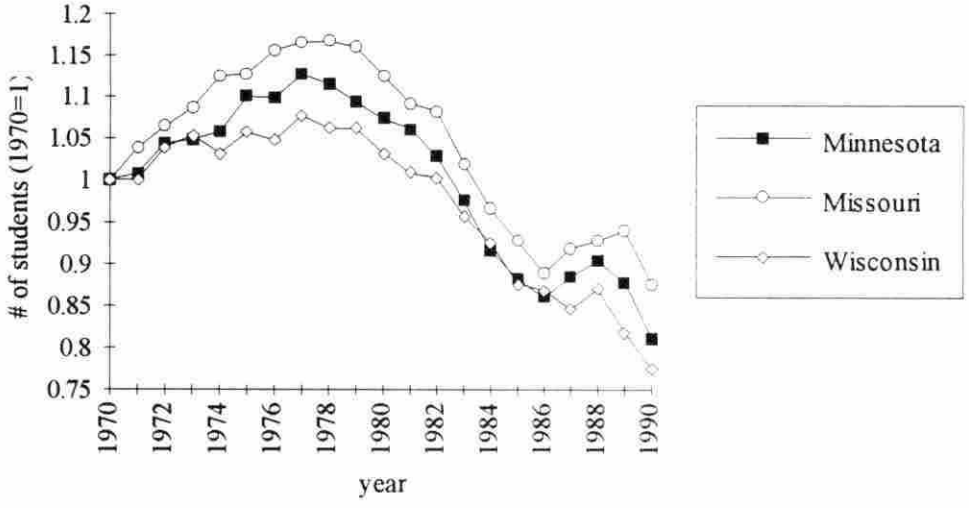

Figure 3.12. Index of high school graduates from Minnesota, Missouri and Wisconsin, 1970 - 1990 (1970 = 1).
Source: *Digest of Educational Statistics*.

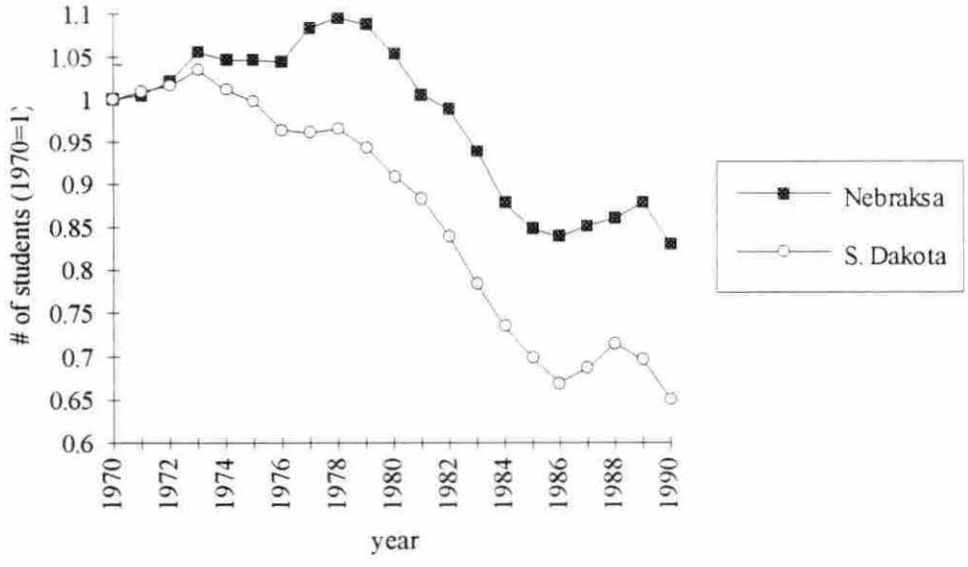

Figure 3.13. Index of high school graduates from Nebraska and South Dakota, 1970 - 1990 (1970 =1).
Source: *Digest of Eductaional Statistics.*

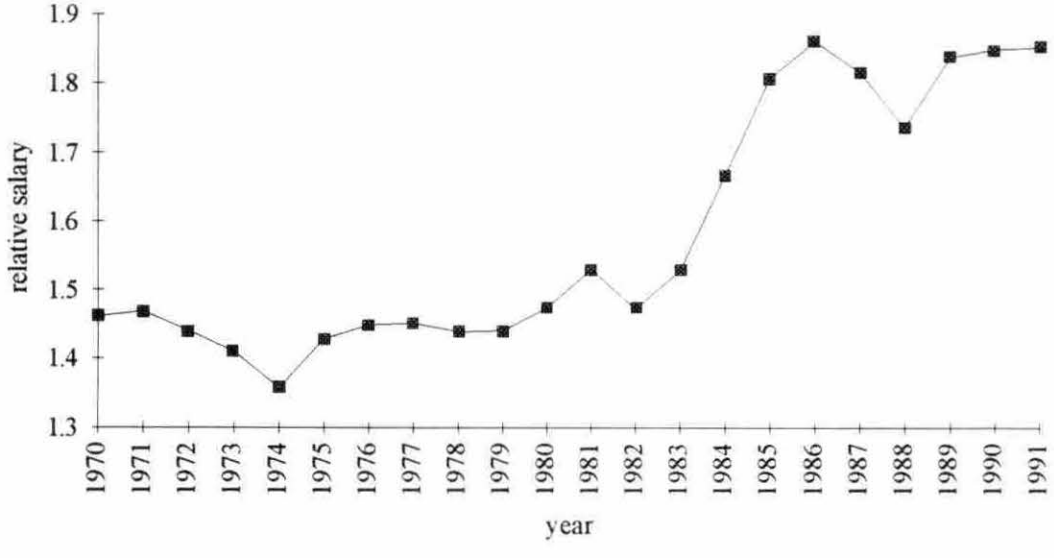

Figure 3.14 National Average annual college salary over high school salary, 1970 - 1991.
Source: *Current Population Survey.*

CHAPTER 4

CONCLUDING REMARKS

This paper has dealt with the factors that influence the decision to enroll in college at the aggregate level. Two levels of enrollment aggregation were examined here. Enrollment at the national level was discussed in Chapter 2. Enrollment at a particular institution, Iowa State University, was examined in Chapter 3. The results found in the national sample yielded less than desirable results when the entire set of data was used. The results improved after removing the interpolated data from the analysis. Many of the problems apparently come from problems with the data set used in this study. The ISU sample, however, yielded results that are consistent with theory and are statistically strong.

The results found in this research have direct implications for policy makers. If they are informed about the likely impact of a decision, they will be better able to carry out the goals they have set for higher education. For example, a university may be able to increase enrollment along with revenues. The federal government can implement programs that allow more students to enter and complete college. The final chapter deals with three main areas. First, the results of the current research will be examined in light of previous studies. Then policy implications that arise from these results will be discussed. Finally, the chapter will conclude with a discussion of future research topics that will both extend the results found here and improve on the research methodology.

Comparison with Previous Literature

The results of this study are important and can give some rather specific implications. However, this study is not to be taken as a final, definitive analysis on the subject. The results of this study need to be checked with other research. Results that are inconsistent with previous research need to be examined again in future research. More to the point, the implementation of a policy based on results that are inconsistent with previous research should

be taken under extreme caution, if at all. The results that are consistent with other research can be implemented with more confidence of their impact on enrollment. A brief discussion of how the results found in the current research compare with past research will follow.

The most important findings in both studies are the results of the coefficients on the price of attending college. Previous research and the law of demand suggest a negative relationship. The current research found the coefficients to be negative. The own price elasticity of higher education was found to be in the inelastic range in the study that examined national trends in enrollment. Past research on national enrollment trends found the elasticity to range in both the elastic and inelastic ranges. The results are consistent for the direction of the change in enrollment from a change in the tuition or cost of attending college. However, there is still room for research as to the magnitude of the impact.

Comparison of the ISU study is slightly more difficult since no other study has examined nonresident enrollment at a specific institution. Four studies, reviewed here, examined individual institutions. However, they either examined only resident enrollment or all enrollments. They found elasticities ranging from -0.66 to -1.74. The elasticities found in the ISU study are above one, in the elastic range. This is consistent with two of the four studies and suggests that revenue from tuition or costs can be increased by reducing the cost of education.

The tuition price at competing institutions is expected to affect enrollment at a given institution positively. The study based on aggregate state enrollment found that increasing tuition in adjacent states increased enrollment in the home state. The private school costs are also found to be negative when only public school enrollment was considered. This result can be compared to the work done by Hight (1975) and Corazzini *et al.* (1972). In particular, Hight found that the impact of private school costs on public school enrollment was positive and in the elastic range. The results found in this research are not consistent with the previous

research. The current research found private school costs have negative coefficients in the inelastic range when public school enrollment was considered. The coefficient of private school tuition or cost is generally negative under both dependent variables examined. However, the coefficients often lack significance.

The response of enrollment to changes in income was also included in many of the studies reviewed here. Generally, previous research on the income elasticity has shown a positive relationship between income and enrollment in public schools. The income elasticities found in the ISU study are positive and in the range of luxury goods. Two previous studies that examined individual institutions (Chressanthis (1986) and Lehr and Newton (1987)) found income elasticities to be 1.39 and 1.88. The other studies reviewed here found positive income elasticities, but not always greater than 1. The income elasticities for the national study were positive in the OLS models and models using actual data. As was common with coefficients that were not consistent with theory, the income coefficients that were negative were often insignificant.

The impact of the draft deferment program in the national study was found to be positive. The deferment program was not examined in the ISU study. The draft deferment ended in 1971 and data for ISU enrollment began in 1973. Mattila (1982) examined the impact of the military build up on enrollments. He found that the draft was positively related to college enrollments. The findings of the current research are consistent with this result.

The unemployment rate was also examined in the current research. It was generally found to be positively related to enrollment. These findings are consistent with a few of the studies. Corazzini *et al.* (1972) and Mattila (1982) found the unemployment rate to positively influence enrollment, although it should be noted that Mattila found the impact to be small. Hoenack and Weiler (1979) discussed the various theoretical explanations of the unemployment rate. Their results found that the unemployment rate was negatively related to

new enrollees and transfer students at the University of Minnesota, but positively related to continuing students and students who enrolled at other Minnesota institutions. The results found in the study dealing with Iowa State enrollments found the coefficient of the unemployment rate to be positive and significant. The coefficients found in the current research are larger than Mattila found. This may be a result of the unusually high unemployment rates of the 1980s. Mattila's data set ended in 1979, before the unemployment rate of 18-19 year olds went above 20 percent.

The other results were not widely used in past research; comparison of similar variables might be inferred, but the reliability of the comparisons may be suspect. The stylized facts of the studies done to date suggest the following relationships:

1. Enrollment levels are negatively related to the price of education.
2. Increases in family income tend to increase public school enrollment.
3. Military draft deferment programs tend to increase college enrollment.
4. The impact of the unemployment rate is shown here to be positive, but there is still debate on the issue.

Policy Implications

The implications of the current research are directed at two levels. The national study discussed in Chapter 2 would have implications on any governing body that deals with higher education, provided reliable estimates can be derived. This includes persons on the planning boards of universities and private institutions to government officials at all levels. These implications are under the assumption that the end goal is to increase the availability of a college education to those individuals who are interested and qualified. The implications mentioned below come from the OLS results. They can be summarized by the following statements:

- An increase in the resident tuition (or costs) is expected to lead to a decline in

enrollment that is less than proportional.

- An increase in family income leads to an increase in enrollment that is less than proportional.
- The number of high school graduates is positively related to college enrollment, and changes are nearly proportional.
- Unemployment rates are found to vary positively with enrollment.
- The draft deferment program in the late sixties increased college enrollment levels.
- An increase in the tuition levels of surrounding states tends to increase enrollment levels for all institutions in that state.
- The cost of a private education was found to have a negative influence on all college enrollment and ambiguously affect the enrollment at public schools.

The last three conclusions require further study. The results were generally found to be true; however, they were often insignificant. The implications of some of the findings are clear. However, it is noted that many of the findings are not based on decisions made by planners. The unemployment rate, the number of high school graduates, and changes in the military policies are not decisions made by higher education planners. Rather, these results can be used by college officials to estimate future enrollment levels. This may aid in supporting requests for budget adjustments based on enrollment projections.

The results of the tuition and income measures are important to planners. The planners must understand that an increase in the cost of attending college will decrease enrollment. Perhaps of more interest to planners today is that enrollment levels can be increased by lowering costs. This is, however, not achieved without a cost to the institution. Since the elasticities are found to be less than one (inelastic), a reduction in tuition will increase enrollment at the expense of decreasing tuition revenues. A reduction in the costs of education, say by expanding government support for loans or scholarships, can be viewed as

de facto tuition reductions. The small elasticities suggest that making such funds more generally available to students would have a minor impact on total enrollment. Current business cycle conditions, as captured by the unemployment rate movements, are more important.

The members of government may be interested to know that they can pursue two avenues of making college more accessible. They can decrease the costs for the students as discussed above, or they can increase the income of the family with college age students. The current findings also indicate that the plan of Senator Grassley in 1992 to have a reduction in the taxes paid by families with college age students, may also be an effective method of making college education available to more students. Specifically, the results from the OLS model that considered total costs found that if income were increased by 1 percent enrollments would increase by one-quarter of one percent. The other specifications, however, indicate a much smaller increase, and in some cases a decrease.

The results discussed in Chapter 3 relate specifically to Iowa State University; however, there are again some impacts that may very well generalize to any institution of higher education:

- The total cost of a nonresident attending ISU is negatively related to nonresident enrollment, with elasticities in the elastic range.
- An increase in family income increases nonresident enrollment at ISU.
- Resident tuition or costs in the student's own state has a positive relationship to nonresident enrollment at ISU.
- The distance from Iowa negatively influences nonresident enrollment at ISU.
- Iowa State has not seen a severe decrease in enrollment from the declining high school graduate populations nationally.
- The number of ISU alumni is positively related to enrollment, but the impact is

relatively small.

- The unemployment rate of 18-19 year old persons is found to be positively related to enrollment.
- Iowa State has yet to see an increase in enrollment from the increase in returns to college education.

The results of this study are specific to Iowa State University. The administration at ISU and legislature of Iowa can benefit from examining the impact of their decisions in light of these findings along with other studies. It is again clear that ISU cannot control many of these factors. However, the decisions that ISU can make have crucial impacts on enrollment and revenues.

The most pressing example is the response of enrollment from nonresident costs of attending ISU. Across many specifications, the coefficients were found to be in the elastic range. This indicates that enrollments will fall drastically from any type of tuition or cost increase. However, the past year ISU pressed for a decrease in nonresident tuition. The results of this study indicate that nonresident enrollment will increase. They also suggest that revenues from tuition will increase, as well. The current research predicts that revenue increases will be at least one-half of one million dollars and possibly more depending on the elasticity used.

Of the results listed above, ISU can only directly control the tuition or costs of attending ISU. They cannot change family income, or the number of high school graduates. Rather, ISU can use some of the results to increase the effectiveness of their recruiting and marketing efforts. Since distance is negatively related to enrollment, additional marketing efforts will be more effective if the student is relatively closer to ISU. Another implication of this study is that alumni can positively influence enrollment. ISU might consider enlisting the help and support of alumni in recruiting prospective students.

Finally, the results are helpful in planning future enrollment levels. Examining the high school class sizes and understanding their impact on nonresident enrollment at ISU can aid in predicting enrollment at ISU. This is an important issue since many budget items are based on enrollment projections. If the projections are low, finding additional funding may be extremely difficult. Other factors that may aid in predicting future enrollment levels are the unemployment rate and the rate of change in resident tuition in other states. When the number of high school graduates declined by nearly 20 percent, ISU only saw a 10 to 11 percent decline in the number of nonresidents. This may be a result of increased marketing and recruiting efforts by ISU. If this was the case, the additional efforts to reach prospective students were reasonably successful.

Future Research

There is also a need to refine the models used in this study. This is particularly true for the national study of Chapter 2. Although the OLS model performed well, the regressions which corrected for serial correlation yielded poor results. It may be reasonable to examine the effect of including more than a single lag of certain independent variables. There are also problems with the data set. Much of the data had to be interpolated because the data series were discontinued or published sporadically. For several important variables, more than one source was used; this raises the question of consistency across the sources. While adjustments were made to attempt to make the series consistent, a single consistent series is preferred. These are a few of the areas of concern with the data that might be examined in later studies.

Other topics that might be investigated in future research deal with modeling the decision process. One approach that may be fruitful is to model nonresident tuition and enrollment as being determined simultaneously. This would involve estimating simultaneous equations for the two decisions. If universities raise tuition in response to enrollment

pressures, then it is incorrect to use tuition as an exogenous variable in a regression explaining enrollment.

The current research has provided a basis for further research of Iowa State enrollment trends; however, this study is not specific enough to address all of the goals set by the university. Ethnic and racial diversity and student retention are two of the goals that the university has set forth. To analyze factors that might influence these goals, more study needs to be done. A study that uses individual applicants to ISU as the unit of observation would be fruitful in determining what types of factors individuals consider when enrolling at ISU. This study, combined with the results of student success, could aid ISU in recruiting those students who have a greater probability of completing their degree. Such studies could also establish which factors are most important for attracting or retaining specific targeted groups. Many other results are possible from a micro-based study of the students enrolling at ISU. This study may provide a starting place for these and other studies to further examine the demand for higher education.

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APPENDIX

BIAS OF COEFFICIENTS FROM ln (y + 0.1)

Suppose that the model was initially of the form

$$\ln(y) = \ln(x)\beta + \varepsilon_1. \tag{A.1.1}$$

To avoid losing any observation, since ln(0) is not defined, that 0.1 is added to y. Then the model will be of the form

$$\ln(y+0.1) = \ln(x)\beta^* + \varepsilon_2 \tag{A.1.2}$$

To examine the bias in the estimates of β, totally differentiate (A.1.1) and (A.1.2) and solve for the β's. The solution from the first equation will be

$$\beta = \frac{dy}{dx}\frac{x}{y}. \tag{A.1.3}$$

Similarly, for (A.1.2) the result will be

$$\beta^* = \frac{dy}{dx}\frac{x}{(y+0.1)}. \tag{A.1.4}$$

Then the bias of the coefficients will be φ, where

$$\beta^* - \beta = \frac{dy}{dx}\left(\frac{x}{(y+0.1)} - \frac{x}{y}\right) = \varphi. \tag{A.1.5}$$

Then solve (A.1.3) for (dy/dx) and substituting into (A.1.5) results in

$$\varphi = \beta\frac{y}{x}\left(\frac{x}{(y+0.1)} - \frac{x}{y}\right) = \beta\left(\frac{y}{(y+0.1)} - 1\right) \tag{A.1.6}$$

Because the term in parentheses is negative, β^* will understate the true β. The relationship between β^* and the true coefficient is β can also be expressed by

$$\beta^* = \beta + \beta\left(\frac{y}{(y+0.1)} - 1\right) = \beta\left(\frac{y}{(y+0.1)}\right). \tag{A.1.7}$$

Therefore, the bias of the coefficients depends on the size of the enrollment from each state. At the mean ISU nonresident enrollment from all 49 states, 22.875 students, the coefficients would be biased by 0.9956. The bias is more of a problem when the enrollment numbers are small. For example, if only one person enrolls from a state then the bias would

be 0.909. The bias is insignificant when enrollment number are higher. The border states have a mean enrollment of 146.426. This will bias the estimates by only 0.9993.