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UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

# AN ANALYSIS OF ECONOMIC DETERMINANTS AND THE RELATED EFFECTS ON THE PRICE ELASTICITY OF ENROLLMENT DEMAND IN FOUR YEAR PUBLIC INSTITUTIONS OF HIGHER EDUCATION IN NORTH CAROLINA

A Dissertation

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

Doctor of Philosophy

By

DAVID R. GILCHRIST
Norman, Oklahoma
1998

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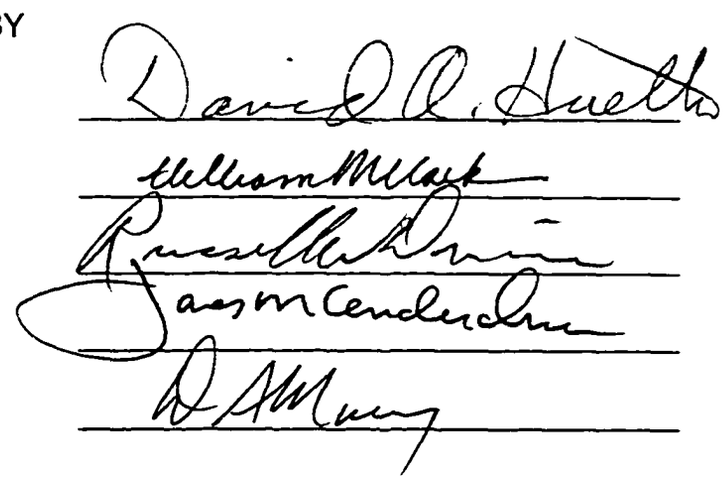
A Dissertation APPROVED FOR THE
DEPARTMENT OF ECONOMICS

BY



ACKNOWLEDGMENTS

I would like to express my sincere appreciation to those many individuals whose encouragement and support has been very valuable to me during my graduate studies at the University of Oklahoma.

I would also like to express my special appreciation to all the members of my doctoral dissertation committee; namely (alphabetically), Dr. Will Clark, Dr. Russell Driver, Dr. David Huettner, Dr. James Kenderdine, and Dr. Don Murry; and my graduate college liaison, Dr. Alexander J. Kondonassis. I would also like to express my special appreciation to Dr. Eddie Carol Smith, Dean of the Graduate College at University of Oklahoma, for his words of wisdom and inspiring conversations. I have had the wonderful privilege to work with each of these fine academicians over the last several years, and as a result, have gained new insights into my areas of academic inquiry as well as a higher level of understanding of me. They all have had a positive impact on my life beyond measure. Appreciation is expressed to these fine men for their valuable guidance, advice, suggestions, constructive criticisms, and encouragement throughout my studies.

Thank God for His many acts of grace and mercy that He has given me. My prayer is that God will use the talent and abilities that I have developed and

refined through my academic studies at the University of Oklahoma, so that I may have a positive influence upon the lives of others whose path I may cross throughout the remainder of my life's journey with Him. May God help me to give myself selflessly to the service of others and to use me especially in the area of academics and to be instrumental in accomplishing His Kingdom's business here on earth.

## DEDICATIONS

To God Almighty, the Master of the universe, I want to thank for the talent and abilities that He has blessed me with, including the ability of persistence and determination. He has given the wonderful ability to keep on going and to never, never give up on anything when I really believe in it.

To my parents, Wilbur (now deceased) and Catherine Gilchrist, whom I love dearly. Their love for each other, for God, and for me, gave me inspiration and strength.

To my children, David and Caroline, now age 10, who have taught me many lessons about unconditional love, about life, and have helped me in many ways, beyond measure, to come to a better understanding of myself and to become a better man.

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## ABSTRACT

The purpose of this research was to model the demand for higher education and to determine if enrollments were price elastic among North Carolina's public four-year institutions. The underlying intent was to check the feasibility of a human capital theory based methodology for examining the demand dependency of higher education in North Carolina institutions of higher education. The price elasticity of enrollments were observed across various institutional groupings to observe the differential effects of these factors given institutional characteristics. The analyses were based upon the investment approach to human capital theory relative to the study of educational demand.

Multiple linear regression was used to model several sets of determinants across different levels of analysis. A cross-sectional design was used in this research. Therefore, the resultant demand models were descriptive only of the time period covered in these analyses. Nevertheless, such research should be useful in assessing the impact on enrollments of selected demand factors and in determining the efficacy of the investment approach applied in this research.

In the current research, logarithm transformations were utilized for several measures since they produce constant elasticities for the related factors. There are alternative methodologies that can be utilized. Some of these alternatives are addressed including: (1) the Probit model; and (2) the Logit model. The difference between the Logit and Probit models is in the assumptions made regarding the error term. If the error term has a logistic distribution, we have the Logit model. If it has a normal distribution, we have the Probit model. The descriptive results proved to be very similar. All hypotheses were confirmed.

# INTRODUCTION

## Background for the Study

As state government and higher education policy makers confront the uncertainties of the 1990's and the next millennium, they increasingly are concerned about future enrollment in four-year public institutions. Much of this concern stems from an awareness that institutions of higher education are dependent on specific groups and subgroups of prospective students. Not only do these dependencies vary from institution to institution, but the degree of dependency varies with factors often beyond the control of the policy maker. While the supply of students from a group may be beyond the immediate control of the decision maker, it is critical that the policy maker be aware and thus forewarned of possible shifts in the influx of potential enrollees. Given this knowledge, steps can be taken which help to ensure the future vitality of an institution and of an effective statewide system of higher education.

Research on the demand for higher education and, hence, the degree to which an institution can depend on a given pool of prospective students is based primarily on the investment approach to human capital theory developed within the economics discipline. The resultant theory of educational demand assumes

that an individual will decide to invest, or enroll, in higher education if the present value of the expected stream of benefits associated with enrollment is at least equal to the present value of the direct and indirect costs of education (Becker, 1975; Blaug, 1966; Bowen, 1977; and Schultz, 1961). In other words, individuals will display a willingness to invest in themselves by enrolling in a college or university because they believe that such an investment will accrue both financial and psychological benefits.

Studies on the demand for higher education enrollments date from the 1960's, the majority of which are national or regional in scope. Although most studies are consistent in their finding of a negative relation between tuition, or the cost of attendance, and enrollment, the more important and difficult question of how much of an impact costs and other demand related factors have on enrollment is unresolved. Contributing to the difficulty in estimating these effects is the differential impact these factors have across different types of institutions and across different regions of the country (Johnson, 1976; Tannen, 1978; Minter & Bowen, 1982; Carnegie Council on Policy Studies in Higher Education, 1980; and Feldman & Hoenack, 1969). Continued research is required before substantive information on the distributional effects of economic, demographic, and other demand related factors is available at both the state and institutional levels.

Several factors have exposed the need for such information. There are four primary issues confronting higher education in the North Carolina system: (1) teacher education; (2) student aid; (3) education for military personnel; and (4) the costs of higher education. Two of these four issues (student aid and the costs of higher education) reflect concern over enrollment demand in North Carolina. This concern is based on recent request for changes in North Carolina's funding formulas for higher education. These proposed changes may result in increases in the proportion of educational costs borne by students and their families. In addition, evidence has been found to suggest that current financial aid programs are insufficient to meet the financial needs of applicants to North Carolina's four-year public institutions.

These issues are particularly significant in view of other economic and demographic developments in the state. Not unlike the national trend, North Carolina institutions of higher education experienced rapid growth in enrollments over the 1960's and early 1970's. Much of this growth can be attributed to the development of the North Carolina Community College System, which now accounts for over 40 percent of all students enrolled in public institutions.

While demographic changes in the population will undoubtedly affect North Carolina enrollments throughout the remainder of the 1990's and beyond, several economic factors are cited by the UNC Board of Governors for Colleges and Universities (UNCBGCU) that may further curtail the demand for higher

education. The burden of escalating costs for higher education will most likely bear upon the state, and students and their parents. The proposal to increase the share of revenues paid by students is a consequence of federal restrictions. Furthermore, state revenues are also constrained by other economic demands such as an increase in the demands for state revenues for other social areas such as health care, law enforcement, and retirement.

Any declines in high school graduates may be mediated by an increased college-going adult population and sustained financial aid programs, the importance of understanding the demand for higher education among the former group is underscored by UNCBGCU in its long range plans. The increase in older students is not believed to be sufficient to compensate for the decline in traditional 18-24 year old students primarily because the former tend to be part-time and evidence a lower overall demand for higher education. Decreases in full-time entering freshmen also signal a potential lack of revenue to finance dormitories among residential campuses. Changes in financial aid programs, typically targeted toward the full-time undergraduate student, need special attention in the face of rising costs, until it is determined how costs affect enrollment patterns. According to UNCBGCU, such research "will be particularly important as the 18-24 year old group...changes throughout the remainder of the 1990's and beyond, thereby affecting the pool of traditional full-time higher education students" (p. 46, 1981).

## Purpose and Summary

The main purpose of this research was to model the determinants of enrollment, or the demand for higher education, and determine whether or not enrollments were price elastic among North Carolina's public four-year colleges and universities. Given the primarily significant and negative effect of price on enrollments in North Carolina, the magnitude of this effect across different institutional groupings was of considerable interest. The analyses were based upon the investment approach to human capital theory and included: (1) a descriptive overview of selected sets of higher education enrollment determinants representing various economic, noneconomic and environmental factors; and (2) statistical analyses of the specific variables comprising each set of determinants, including estimates of price elasticity.

Multiple linear regression was used to model the determinants across three levels of analysis: (1) for all institutions combined; (2) for three major institutional groups; and (3) for each individual institution. All variables were measured to correspond with a 1995-1996 time frame. In general, it was found that the direct cost of attendance, the size of the eligible population of students, the educational attainment level for the locale in which students reside, and the rural versus urban nature of this same locale had significant effects on enrollment among North Carolina's four-year institutions. Price, or the direct cost

of attendance, and the rural nature of students' environment had a primarily negative effect on enrollment, while the educational attainment level and size of the high school graduate population had positive effects on enrollment.

Differential effects across institutional groupings were observed particularly with regard to price. The Direct cost of attendance proved to be nonsignificant, with mixed coefficient signs. The size of the eligible population and the rural nature of students' environment reflected the dependency of some institutions on nearby localities, as well as the possible substitution of other enrollment options for public, four-year enrollments. Also, since the price variable included the cost of living expenses for those students estimated to live beyond a reasonable commuting distance to a given public, four-year institution, this variable reflected the tendency of students to choose nearby as opposed to distant institutions. The price effect was particularly strong and negative for urban institutions---indicating the dependency of these institutions on their local region for their enrollment base.

It should be noted that this research was based on aggregate rather than individual student data. Reasons for using aggregate rather than individual data included the unavailability of certain data and the lack of standard reporting practices across different institutions with regard to the individual student. Since the purpose of this research was directed toward statewide enrollment planning efforts, it was considered more appropriate to focus on the study of demand at

the macro level by the hypothetical average individual rather than on demand at the micro level by the unique individual. Such research should be useful both in assessing the impact on enrollments of selected demand factors and in determining the efficacy of the investment approach applied in this and similar research efforts.

In the current research, logarithmic transformations were utilized for several measures since they produce constant elasticities for the related factors. Some other models were given consideration in this research; namely, (1) linear probability model; (2) the logit model; and (3) the probit model.

The linear probability model has the drawback that the predicted values can be outside the permissible interval (0,1). In the analysis of models with dummy dependent variables, we assume the existence of a latent (unobserved) continuous variable which is specified as the usual regression model. However, the latent variable can be observed only as a dichotomous variable.

The difference between the logit and probit models is in the assumptions made about the error term. If the error term has a logistic distribution, we have the logit model. If the error term has a normal distribution, we have the probit model. When the logit and probit models are computed, adjustments have to be made with respect to the coefficients in order to make them comparable. From the practical point of view, there is not much to choose between the two models in that the results are very similar.

For comparing the linear probability, logit, and probit models, we can observe the number of cases correctly predicted. However, this is not always adequate. It is usually better to look at some other measures of $R^2$.

The tobit model is a censored regression model. Observations on the latent variable are missing (censored) if the latent variable is below (or above) a certain threshold level. This model is observed to be zero for some individuals in the population sample (education expenditures, hours worked while in school, wages, etc.). However, upon a careful analysis, we find that the censored regression model (tobit model) is inappropriate for the analysis of these type of issues and research problems. In essence, the tobit model is applicable in only those situations where the latent variable can (in principle) take on negative values. However, these negative values are not observed because of censoring. Since there are cases where the zero observations are a consequence of individual decisions, the tobit model was not used in this research.

# LITERATURE REVIEW

## Human Capital Theory

The development and maintenance of economic growth are perpetual concerns of economists and political policy makers in both advanced industrial economies and in economies hoping to advance. Many models designed to explain and predict economic growth have incorporated a population component (Becker & Murphy, 1990). When early models of this type failed to adequately explain economic growth, neoclassical economists developed a model "essentially ignoring any link between population and the economy" (Becker & Murphy, 1990, p. 13).

As the neoclassic model also fell on hard times, some economists initiated a reappraisal of the relationship between population and growth (Tomes, 1981). In this reappraisal, however, the concept of human capital was substituted for a raw population variable (Becker & Murphy, 1990). In the models developed through the reappraisal process, human capital was defined as "embodied knowledge and skills" (Becker & Murphy, 1990, p. 13). The underlying assumption of such models was that as "economic development depends on

advances in technological and scientific knowledge, development presumably depends on the accumulation of human capital" (Becker & Murphy, 1990, p. 13).

Economic growth is typically defined in positive terms as the rate of change in gross national product-GNP. Within this definition, a decline in GNP would be referred to as negative growth. There are two general types of economic growth. Extensive economic growth refers to an expansion of the total output of goods and services, regardless of the change in per capita output. Intensive economic growth refers to an increase in per capita output.

Development is a normative concept that encompasses economic growth, but which also includes structural and distribution changes which should lead to improvements in the living standard for a majority of an economy's population. Thus, if economic growth occurs, but most of the benefits of such growth accrue to a relatively small economic elite, then positive development in that society has not occurred.

Becker and Murphy (1990) based the assumption of a relationship between human capital and economic growth on observations of the American economy that indicated that: (1) growth in investment in schooling grew much more rapidly than gross investment in physical capital; and (2) that growth in years of schooling explained approximately 25 percent in growth in per capita income. The theoretical justification for the assumed relationship between earnings and educational attainment is based on the concept of differential

pricing for educational attainment. Higher levels of formal educational attainment are held to increase the value of the human capital possessed and offered by the individual. In most cases, also, higher levels of formal educational attainment are associated with lower supplies of individuals so qualified. Thus, supply and demand also affects the differential pricing of education.

National development is viewed as a system, which encompasses both educational development and economic development. It is, thus, within this system that the two are related to one another. Within a system of national development, the outputs of the educational development subsystem are inputs to the economic development subsystem. Education: (1) contributes to productivity through its spillover effect, and through reorganization of the working process; (2) stimulates technological innovation, which leads to higher productivity; (3) increases allocative efficiency in response to the fluidity and flexibility of labor, and through the increased demand for labor; and (4) creates social and economic attributes which support economic development. Without widespread literacy provided by education, it is often held that the whole fabric of society would begin to unravel. Spending on education, thus, "should be regarded as a productive investment, rather than pure consumption" (Psacharopoulos and Woodhall, 1986, p. 22).

Becker and Murphy (1990, p. 13) held that crucial to their "analysis is the assumption that rates of return on investments in human capital rise rather than

decline as the stock of human capital increases." The reasoning underlying this assumption "is that education and other sectors that produce human capital use educated and other skilled inputs more intensively than sectors that produce consumption goods and physical capital" (Becker & Murphy, 1990, pp. 13-14). Carrying this thought a step further, Becker and Murphy (1990 held that this process "leads to multiple steady states: an undeveloped steady state with little human capital and low rates of return on investments in human capital, and a developed steady state with much higher rates of return and a large and perhaps growing stock of human capital" (p. 14).

The approach of Becker and Murphy (1990) to the development of a human capital model of economic growth relied "on the assumption that higher fertility of the present generation increases the discount on per capita future consumption in the intertemporal utility functions that guide consumption and other decisions" (p. 14). Thus, it was reasoned "higher fertility discourages investments in both human and physical capital. Conversely, higher stocks of capital reduce the demand for children because that raises the cost of time spent on child care" (Becker & Murphy, 1990, p. 14).

Resource development within a society involves the development of human resources, as well as the development of the physical resources of the society. All too many developing countries have emphasized the development of their natural resources, at the expense of the development of their human

resources. One of the ways in which this type of action typically occurs is through the development of extractive or harvesting industries, where processing is done in an industrialized country. This type of natural resource development provides only minimal benefits for the greater proportion of the population of the country involved. In most such instances, most of the wealth generated by the resource development goes to organizations and individuals located in the industrialized countries, while that wealth which generated in the developing country is concentrated in relatively few hands.

When human resource development accompanies the development of a natural resource, the skills and the incomes of a significantly greater proportion of the population of the developing country concerned also are improved. The situation described, of course, assumes an ideal situation for a developing country--the possession of both human and natural resources. Many developing countries, unfortunately, have only their human resource for development.

One of the major problems encountered by the leaders of developing countries in the context of economic distribution is that of accommodating within their own societies the western perceptions of modernity. The most successful of the western societies in economic terms appear to many observers in developing countries to be, essentially, materialistic in character. Thus, when individuals in developing countries equate modernity with Japanese, North American, or Western European societies, as an example, they may well also

equate modernity with material well-being. Such a concept is an anathema to many cultures. When leaders of developing societies encounter such situations, they must develop means of satisfying their populations, without at the same time destroying the society's underlying value structure.

In any theory of economic development, land is considered to be a part of capital, although differences in the quality of land significantly affect the progress of economic development within countries (Thurow, 1988). The quality of land offers a valid explanation as to why some countries develop or have developed at rates faster than those of their world neighbors. More rapid development may be spurred by land which permits highly productive agriculture, which, in turn releases labor for employment in industry. It may also be spurred by land which provides the natural resources required for industrial development, or it may be spurred by a combination of these conditions, although such a combination has not occurred often.

Economic growth and development depends upon the formation of two types of capital--human capital and financial capital. In this context, the population of a country is considered to be one of its basic resources, which must be used as a form of capital for its economic development. The population of a country is formed into human capital through the process of education and through the replacement of human labor by technology, in order to free human labor for higher uses (Romer, 1990).

In order to form a population into human capital, however, resources must be allocated to the task. For all countries, and particularly for developing countries, the allocation of resources to the development of human capital means that some other sector of the economy or of the society will be deprived, to some extent, in the short-run. In the long-run, of course, all other factors remaining equal, the economy of the country will ultimately benefit from the formation of a population into human capital (King & Rebelo, 1990).

The development of a population into human capital, however, does not mean that a country will be capable of effectively employing all of the available human capital. If the land of the country does not provide the resources required for intensive industrial development, a surplus of human capital will be created by improving the productivity of agriculture (low productivity agriculture creates a useful purpose for a large population which cannot be accommodated by industrial development).

The financial capital of a country is typically considered to be those goods which yield no immediate utility, but which are capable of producing goods which may yield utility. In this context, financial capital includes both monetary goods and other capital goods which may be acquired with monetary goods. The capital of a country increases through the process of net investment, which is the difference between a country's net income and how much it consumes out of that income. Capital accumulation enlarges a country's capacity to produce

goods. Developing economies lay great emphasis on the importance of capital accumulation and stress the need to raise the level of investment in relation to output. Development is associated with industrialization, and industrialization is associated with capital accumulation.

Obstacles to economic growth and development in the developing countries include dualism, cumulative causation, and the problem of population. Dualism is economic and social divisions in an economy, such as differences in the level of technology between sectors or regions, differences in the degree of geographic development, and differences in social customs and attitudes between indigenous and an imported social system (Romer, 1990). Dualism is a state of affairs in which developing countries may find themselves in the early stages of development, and which may have significant implications for their later development.

Effective attempts to eliminate social imbalances typically must be based upon the acceptance of the philosophical tenet of equality. In many developing economies, the reactionary belief in innate differences in quality between groups of people having different standards of economic well-being tends to persist (Tomes, 1981). According to this interpretation, it would be difficult to eliminate many of the manifestations of dualism without a preceding change in philosophical outlook.

The process of cumulative causation attempts to account for the persistence of spatial differences in a wide variety of developmental indices between countries and between regions within a single country on the basis of the existence of geographic dualism. The contention is that, in the context of development, both economic and social forces produce tendencies towards disequilibrium, and that the assumption in economic theory that disequilibrium situations tend toward equilibrium if false.

Development financing may be derived from two very general sources; domestic resources and external resources. The basic premise of the financing of development from domestic resources is that of net investment--consume less than that produced. In order to formulate financial capital through the process of net investment, however, either a number of different or a combination of policies must be pursued. These policies are related to the type of monetary and fiscal programs pursued by the countries concerned, the ability of the leaders of a country to stimulate domestic savings, and the ability of the monetary and fiscal managers within a country to control the level of domestic price inflation. Most developing economies in the twentieth century have not been capable of financing economic development at the level, or at the rate desired solely through the use of domestic resources.

One solution to the problem of surplus human capital is the implementation of policies which permit the free movement of human capital

across national borders. While the solution is a good one, it is a difficult one upon which to gain widespread international agreement.

The high profile consumption societies in the United States, Japan, and some oil-rich Middle East countries have caused many in the developing countries to want increased production and consumption now, as opposed to the longer period of time required for reaching such increased levels through capital accumulation derived through the process of net investment. These pressures have created significant difficulties for economic development.

The problems of dualism, and more particularly, of cumulative causation, cause some developing countries to pursue goals of national economic planning (King & Rebelo, 1990). Such planning is viewed as the best way to overcome these obstacles to economic growth and development.

When speaking of the population "problem," the formation of human capital from a country's population is viewed as one of the essential ingredients of economic growth and development for developing economies (Becker & Murphy, 1990, p. 14). The common view (in the context of the developing economies) is that rapid population growth presents an obstacle to the growth of living standards. After reviewing all of the facets of the "problem" of population, however, it has been found that most developing countries were experiencing income growth faster than the rate of growth of population. Whether income growth would be faster if population growth was reduced is an open question. It

is possible to conceive of a low-level equilibrium trap, but its level almost certainly rises over time owing largely to technical progress before a reduction in birth rates begins. In the contemporary time period, it is quite likely that the rapid population growth in most of the developing economies will have a decidedly adverse impact on the growth and development of these economies.

Becker and Murphy (1990) stated that, where "in neoclassical models, the rate of return on physical capital investment is assumed to fall as the per capita stock of physical capital increases," a "corresponding assumption for human capital is less plausible since human capital is knowledge embodied in people" (p. 15). Thus, Becker and Murphy (1990) held that "rates of return on human capital do not monotonically decline as the stock of human capital increases. Rates of return are low when there is little human capital, and they grow at least for a while as human capital increases" (p. 16).

Becker and Murphy (1990) held that human capital "has a more fundamental role than physical capital in determining steady-state equilibria. Given the human capital investment function, the initial level of per capita human capital determines where the economy ends up, regardless of the initial stock of physical capital" (p. 19).

Essentially, Becker and Murphy (1990) contended that the two stable steady states derived through the application of the human capital model means that one type of economy (underdeveloped) "has large families and little human

capital," while the second type of economy (developed) has small families and perhaps growing human and physical capital" (p. 12). Romer (1990, p. 71) supported the conclusions of Becker and Murphy (1990), holding that "the stock of human capital determines the rate of growth,...that integration into world markets will increase growth rates, and that having a large population is not sufficient to generate growth" (p. 36). King and Rebelo (1990) provided peripheral support for the conclusions of Becker and Murphy (1990) in their finding that taxes levied to support welfare payments to a large population tend to stifle economic growth.

Rosenzweig (1990), however, both supported and challenged the findings and conclusions of Becker and Murphy (1990). Rosenzweig (1990) supported Becker and Murphy (1990) with a finding the "alterations in the returns to human capital associated with exogenous technical change lead simultaneously to increases in human capital investments and to reductions in fertility" (p. 38). As a cautionary note, however, Rosenzweig (1990) stated that, although "high-income countries have been and are characterized by low fertility and high levels of human capital," and "low-income countries are characterized by high fertility and low levels of human capital," such "aggregate associations...by themselves do not reveal very much about the determinants of economy growth" (p. 39).

In relating the theory of human capital to the context of higher education enrollment, it is reasonable to infer that variations in factors influencing the

expected stream of benefits (or rate of return) are related to variations in enrollment or demand. For instance, a rise in the expected monetary returns resulting from education should increase enrollment, while an increase in the costs of education should decrease enrollment.

This argument forms the basis of the human capital investment approach to educational or enrollment demand. Briefly, this approach hypothesizes that variations in the demand for higher education will be associated with those factors that affect the expected stream of benefits to investment in higher education. Consequently, it may be expected that: (1) the demand for higher education will vary inversely with the direct and indirect costs of education (i.e., higher costs result in less demand); and (2) the demand for higher education will vary positively with those factors which enhance, or reduce the uncertainty of, opportunities to realize future expected returns to college enrollment (i.e., higher returns result in higher enrollments).

Since Campbell and Siegel's related work on enrollment demand in 1967, applied research in this area has shown increased sophistication. Simultaneously, the research has been quite disparate, incorporating a variety of data bases, functional forms, conceptual approaches, and estimation techniques. Study of the literature, however, reveals several common issues which must be considered. These issues were used in this study as criteria for evaluating five of the more prominent higher education demand studies to

demonstrate the treatment of those problems which arise in investigating enrollment demand.

The remainder of this chapter is devoted to the identification and discussion of the evaluation criteria. A complete discussion of reviewed studies of past research is presented in appendix F.

## Evaluation Criteria

Although the enrollment demand research based on human capital theory has been disparate with regard to methodological and conceptual approaches, several specification issues or problems prove to be crucial in conducting research on enrollment demand. Five such issues are identified and discussed in this section.

### 1. Identification of Correlates of Demand

In traditional economics, the demand for a service is assumed to be a continuous function of economic and environmental factors. In general, the key factors included in demand analyses are: price, tastes and preferences, number of consumers, consumer incomes, prices of related goods, and range of goods available (Leftwich, 1964). Based on these factors, educational economists have identified at least three categories of demand determinants which may be classified as: (1) economic--factors demonstrating the direct/indirect costs of

enrollment and the ability to finance education; (2) noneconomic--factors demonstrating academic ability, educational background, and tastes or preferences; and (3) environmental--factors demonstrating familial, local, or regional characteristics which influence the propensity to attend college. In general, these determinants reflect correlates of demand resident in the person (i.e., the student or the student as represented by the family unit) versus those resident in external factors (e.g., an institution, local area, government policy, etc.).

Factors resident in student. Two economic factors related directly to the student (or the student and his/her family) are suggested by the investment approach to demand analysis. These are ability to pay and socioeconomic level. Since most research on enrollment demand focuses on beginning entering freshmen, these factors typically are measured at the corporate, or family, level because most freshmen students are presumed to rely on family resources to finance their postsecondary education. Family income, therefore, represents students' ability to finance their investment in higher education. As family wealth increases, there is less constraint on the option to pursue further education and students and their families are more likely to choose institutions whose costs/returns are relatively high. Socioeconomic level is sometimes used as a proxy for family income. However, it more often is used to stratify data in order to examine the

distributional effects of family status on enrollment demand. Both family income and socioeconomic level are expected to bear positively on demand.

Noneconomic demand factors resident in the student include academic ability, sex, and race. Student ability reflects not only the students' capacity to overcome any nonprice rationing that may exist via college admissions policies, but also the students' probable expected return from a college education. In other words, the higher the students' ability, the less their risk in investing their resources (nonmonetary and monetary) in higher education (Blaug, 1966; and Becker, 1975). Academic ability also is assumed to be related to the students' tastes and preferences for education; that is, students of higher ability will prefer to continue their education, and most likely, at relatively selective institutions. Student ability is expected to have a positive impact on enrollment.

Use of sex and race variables has been slight in enrollment demand studies. In most cases, these variables were included to examine the distributional effects of explanatory variables on various sex/race subgroups. While Becker's (1975) theoretical and empirical analyses of the differing rates of return to higher education for white males, nonwhites, and females concluded that white males realized the highest rate of return (and, therefore, were more likely to attend college), significant results for sex, at least, have not been evidenced in past applied demand studies (Radner & Miller, 1975; and Tierney, 1980). According to Becker, variation in rates of return within a given sex/race

group was much greater than could be explained by the variation in ability alone. Thus, sex/race cohort differences may not be as helpful in examining enrollment patterns as other student demographic variables. Nevertheless, more research incorporating sex/race cohorts is required before substantive comment about the differential effects of sex/race on enrollment demand is possible.

Environmental factors unique to students involve their family background. Parents' educational level or attainment has been the primary focus for this category of factors. Drawing upon the sociological research on educational tastes, researchers of educational demand have argued that enrollment demand increases as successive generations achieve ever higher terminal education levels (Blaug, 1966: and Brazer & David, 1962). This variable has been used frequently as a proxy for family income. However, its function as an indicator of students' propensity or taste for higher education was most often noted. Studies have shown that family educational background has a differential positive effect across various income groups, the strongest effect being evidenced at lower socioeconomic levels. Financial difficulties notwithstanding, students may still be inclined to continue their education due to the regard for education present in their home environment.

External factors of control. The human capital approach to educational demand recognizes that expenditures on education represent an investment not

fundamentally unlike other modes of investment. The resultant theory of educational demand assumes that students will decide to invest, or enroll, in higher education if the present value of the expected stream of benefits associated with enrollment is at least equal to the present value of the direct and indirect costs of education (Becker, 1975; Blaug, 1966; Bowen, 1977; and Schultz, 1961). These costs represent the economic category of external factors influencing enrollment demand.

The costs of higher education are divided into two components: (1) direct; and (2) indirect. Direct costs include direct monetary outlays in the form of tuition, special fees, differential living fees, and other expenditures incidental to college attendance.[1] Indirect costs are viewed in the form of opportunity costs. Opportunity costs refer to the loss of time and income that students would have realized had they not been enrolled in college and had been engaged in income producing activity (Becker, 1975; Blaug, 1966; and Schultz, 1961). Together, these direct/indirect costs introduce the price variable included in traditional economic demand analysis. It is expected that the demand for enrollment will

[1]While financial aid may also be considered a component of direct cost, very few major studies have taken into account the influence of financial aid or federal, state, and institutional interventions.

vary inversely with the direct costs of education (i.e., higher costs result in less demand).

A potential confluence of effects for indirect costs makes it difficult to hypothesize the direction of the relationship between indirect costs and enrollment. In other words, higher opportunity costs may negatively influence enrollment; yet, at the same time, provide a greater opportunity to pay the direct costs of enrollment. Higher unemployment rates may increase enrollments since potential students would have difficulty finding jobs, but may also diminish the ability of households to support the further education of recent high school graduates. Thus, hypotheses about the effects of indirect costs are sometimes avoided. However, a general hypothesis supported by some researchers argues that higher opportunity costs decrease the demand for enrollment while higher unemployment increases demand (Bishop, 1977; Corazzini, 1972; Rusk, Leslie, & Brinkman, 1982; and Salley, 1977).

Results for economic variables, particularly income and price, are typically expressed in terms of elasticity coefficients. In enrollment demand studies, the term "elasticity" is used to designate the relative responsiveness of enrollment (the quantity of education demanded) with respect to a specified determinant. To estimate a constant elasticity requires a double-log transformation of the dependent variable (Y) and the independent variable (X) in question. This

transformation allows the assumptions of both a constant and a proportionate relationship between X and Y, where the resulting estimate reflects a proportionate change in Y resulting from a proportionate change in X. In this regard, elasticity estimates are particularly useful because they are "unit-free" and the effects of the variable to which they apply may be expressed in terms of percentage changes. The elasticity of Y (or enrollment) with respect to X (or price, for example) is referred to as the "X elasticity of enrollment" (or the price elasticity of enrollment). However, the dependent variable is usually understood; thus, one would simply refer to the "X elasticity" (or price elasticity) (Pindyck & Rubinfeld, 1980; and Tufte, 1974).

Noneconomic influences on the demand for enrollment have to do with the range of institutions, programs, and admissions policies present in what Blaug (1966; 1972) calls the "educational market". Considering first nonprice rationing policies, such as minimum admission requirements, religious affiliation restrictions, or single-sex enrollment policies, those institutions that implement such measures are restricting their market and, in effect, reducing demand for enrollment. In other words, different minimum academic requirements define alternative demand curves for the institution, the highest possible demand being associated with the least restrictive requirement--possession of a high school diploma in most cases (Hight, 1975). While such administrative rationing may

influence the distribution of students among individual institutions, it is not likely that such rationing effectively denies any high school graduate access to all of higher education, particularly in the public sector (Blaug, 1966; Corazzini, 1972; and Hopkins, 1974).

According to the investment motive of human capital theory, students choose to attend a given institution based on an evaluation of its relative costs and benefits. In other words, students associate different rates of return with alternative investment options to arrive at their decision. In this regard, the availability of institutions within the higher education market offering the desired programs of study, quality of instruction, social atmosphere, or breadth of field certainly comes to bear on students' assessments of benefits. These noneconomic factors, as well as external, economic factors, influence students' perceptions of the varying benefits accruing from enrollment in different institutions. As a result, changes in certain variables, such as tuition, may encourage students to substitute enrollment (investment) in one institution for enrollment in an alternative institution. To the extent that the former institution has been successful, for example, in differentiating its product, the responsiveness to such changes will be less. However, the greater the availability of desirable or good substitutes, the greater the demand, or responsiveness, to price changes (Leftwich, 1964). Still, in some cases, this

substitution effect may result in a "net discouragement effect" where the alternative is not to enroll in another type of institution, but rather, not to enroll in any form of higher education at all (Hopkins, 1974).

In addition to the economic and noneconomic variables discussed thus far, there are environmental factors to be included among the external influences on enrollment demand. One of the more obvious influences in this category is the eligible population factor. Because demand is dependent on the size of its relevant population, this factor is a necessary variable in the analysis of enrollment demand.

Regional or geographic characteristics have been found to demonstrate differences in attitudes toward education as well as the advantages of having a concentration of schools nearby. Regional attitudes reflect traditional or cultural perceptions of the investment value of continued education, while a geographically concentrated pool of higher education institutions provides greater access to and availability of affordable substitutes (Becker, 1975: Feldman & Hoenack, 1969: Hopkins, 1974; Jackson, 1978; Johnson, 1976; and Tannen, 1978). Also, the urban-rural composition of the students' environment is suggested as an influence on enrollment demand. Use of this factor is based on evidence that a person's urban-rural background affects the rate of return to college enrollment, with persons from urban locales realizing the greater return

(Becker, 1975). Consequently, the urban nature of students' environment, a greater concentration of higher education institutions, and the presence of traditional or cultural inclinations towards continued education have a positive impact on the demand for higher education.

2. Measurement of Financial Aid

Research on the demand for higher education has been prompted primarily by concerns over equal opportunity. Early theoretical and empirical work by Schultz (1961), Becker (1964), Blaug (1966), and other educational economists supported the egalitarian view of higher education, promoting it as a means for social and economic upward mobility. Public subsidies were adopted as a result of the concern for equal opportunity and included direct grants, loans, work-study opportunities, and low tuition; institutional funds were also allocated in these forms, drawing upon both restricted and unrestricted sources (Jackson & Weathersby, 1975; and Dickmeyer, Wessels, & Coldren, 1981). The availability of financial aid introduces a variable pricing component to pricing policy decisions which, in effect, allows institutions to be price discriminators at the individual student level (Chapman, 1979). However, there is research on enrollment demand which incorporates the effects of financial aid in general and the differential impact of resultant pricing policies in particular.

Price, or the cost of attending an institution of higher education, includes tuition, room and board, additional fees as required, and financial aid in amount and type. While tuition, fees, and room and board estimates are generally accessible and reliable, similar estimates of financial aid awards have been difficult to obtain. Some studies have used an estimate of the average financial aid award to adjust the overall cost figure (Feldman & Hoenack, 1969; Hight, 1975; Hopkins, 1974; and Tannen, 1978). However, use of such estimates overlooks the differential value of the various forms of aid across different types of institutions. Grants and scholarships do not require repayment and represent a direct subsidy; loans represent a much smaller subsidy in that the present value of the total amount to be repaid is generally less than the present value of the loan; and work-study carries a current burden for the students required to finance their education in this manner (Tierney, 1980). Some studies have attempted to simulate aid awards by type, but have been limited by general data inadequacies or distortions, lack of an acceptable specification of the distribution process, and the possibility of capricious behavior on the part of institutions (Carroll, Mori, Relles, & Weinschrott, 1977; Jackson, 1978; and Tierney, 1980).

Besides introducing a source of bias with respect to the price variable, the failure to estimate financial aid effects also disregards an important aspect in the formulation of pricing policies. With the advent of equal opportunity concerns

came the incentive to consider the composition of the student population enrolled in higher education institutions. Pricing policy, in effect, became a means not only for controlling size, but also composition. Financial aid, in its various forms, allowed the availability of differential aid packages for targeted groups of students.

Measurement of financial aid raises a question also as to the assumption of perfect capital markets in the analysis of educational demand. This assumption maintains that all who wish to purchase an investment will have loan capital available to them (Blaug, 1966). However, due to governmental and institutional interventions and the general difficulty in establishing financial policies for investments in human capital, funds to finance higher education are limited if unavailable for certain groups of students. Most demand studies have developed investment models under the assumption of limited capital markets, focusing on the current wealth from income or savings as the primary constraint on total costs of college attendance. When and if a measure of financial aid is considered, it is assumed to lower the monetary cost of attendance, increasing the present value of investment in higher education. Accordingly, a positive relationship is expected between the level of aid and enrollment.

### 3. Stratification

An important element of demand analysis referenced in previous sections of this chapter is that of differential effects. Disaggregation of data according to selected strata yields insights into the distributional effects of the explanatory variables across these strata. Most studies have found stratification to be significant in that the estimated coefficients differ across cells, suggesting the possibility of aggregation bias from pooling strata in a single overall estimate. Stratification by income, socioeconomic status, ability, family educational background, race, sex, or type of institution has been attempted, with income or ability levels being the most common single choice for stratification. Where the available data have not allowed stratification directly, interaction terms have been included in the model to allow derivation of results comparable to those obtained from stratified data (Weinschrott, 1977).

### 4. Methodology

A methodological issue traditionally plaguing demand analyses is that of the identification problem. In general, the problem of identification refers to a situation where the parameters of supply and demand are confounded in the estimates of the regression coefficients such that the coefficients are biased estimators of the true demand (or supply) behavior. Avoiding the identification

problem is difficult in aggregate time-series studies since those variables identifying the demand curve can jointly determine the supply schedule. Various means can be taken to avoid identification, such as use of individual data, the assumption of a predetermined price variable (for example), or the inclusion of exogenous variables to distinguish the separate supply/demand relationships. Inclusion of exogenous variables, however, can lead to overidentification, where more than one value is obtainable for some parameters (Pindyck & Rubinfeld, 1981; and Weinschrott, 1977).

Most demand studies have used a cross-sectional design to avoid the identification problem. This is advisable particularly in the event that individual data are unavailable. Use of cross-sectional data allows for the assumption of predetermined variables or fixed supply parameters. In addition, cross-sectional data are not as susceptible to occurrences of autocorrelation. At the same time, achieving variation for certain variables can be a problem when using cross-sectional data.

5. Level of Choice

Two aspects of choice have important consequences for specification of the demand model. These are the corporate/independent nature of students' decisions to invest in higher education and the set or range of alternatives

incorporated by the demand model. The former level of choice was referenced earlier in the discussion on measurement of income, or ability to pay. The assumption of choices or decisions about higher education enrollment being either: (1) independent on the students' part; or (2) corporate (including the family and student together), primarily affects the interpretation of factors representing ability to pay, and tastes and preference. Perhaps the independent or corporate assumption alone will not suffice for all purposes; nevertheless, one or the other must be applied to allow reasonable interpretation of results. For instance, one would assume that choices regarding students' curriculum or the specific school attended are largely a parental decision during the lower school years, while choices regarding graduate instruction are independent. However, choices made during high school or undergraduate years probably evidence greater variation between corporate and individual decisions. In general, it is assumed that with regard to prospective freshmen, the choice to enroll or invest in higher education is a corporate activity. Accordingly, family income, environment, or educational level become primary measures for examining the effects of current wealth, and tastes and preferences on enrollment demand (McMahon, 1974).

Student choices, with regard to the level or stage of the choice process, also affect the set of postsecondary options considered in demand analysis. In

general, the levels of the college choice process include: (1) the inclination toward or against college, where the student decides whether or not to consider enrollment in higher education; (2) given the decision to consider enrollment, the determination of which institutions to include in the choice set; and (3) the choice to enroll in a specific institution or not at all (Jackson, 1978; Kohn, Manski, & Mundel, 1974; and Tierney, 1980). Most studies focus on a discrete level of choice or simplify the general model of choice when considering it as a sequential process. Either approach affects specification of the model. Given the level of choice considered in the analysis, valid representation of the choice set in the demand model depends on the inclusion of all relevant alternatives confronting the student and the inclusion of those explanatory variables sufficient for describing the factors that influence this range of alternatives (Weinschrott, 1977). Development of the dependent variable is also affected in that it must cover the demand function defined by the list of explanatory variables.

# METHODOLOGY

## Research Objectives and Approach

Research on the demand for higher education has demonstrated that enrollment demand is a complex function of a number of external and student related determinants. These determinants may be classified as: (1) economic--factors demonstrating the direct/indirect costs of enrollment and the ability to finance education; (2) noneconomic--factors demonstrating academic ability, educational background, tastes or preferences; and (3) environmental--factors demonstrating familial, local, or regional characteristics that influence the propensity to enroll in college. This research drew from each of these categories to develop factors representative of the classical elements of demand analysis--elements that have been adapted by educational economists to the study of enrollment demand.

As indicated in chapter one, the main purpose of this study was to model the determinants of enrollment, or the demand for higher education, and to determine whether or not enrollments were price elastic among North Carolina's public four-year institutions. Given that price affects enrollments, the magnitude of these elasticities across different institutional groupings and across individual

institutions was examined. Based on the investment approach to human capital theory, it was hypothesized that the demand for enrollments would vary inversely with the direct and indirect costs of education and positively with those factors that enhance, or reduce the uncertainty of, opportunities to benefit from enrollment. Consequently, tuition, or the direct cost of higher education enrollment, was expected to bear negatively on demand. Perhaps a more important aspect of this effect was the possibility of differential effects across different populations--in this research, different groups of institutions. If such effects had not been realized, then inquiry into non-price factors would have been advised. Such research was meant to provide officials in the state with an understanding of human capital based methodologies as applied to the study of the demand dependency of higher education institutions.

The remainder of this chapter outlines the methodology used in examining tuition elasticity among North Carolina's four-year institutions. First, a discussion of the dependent variable, or the measure of demand, is provided. Specific problems with regard to enrollment caps and grouping of institutions are addressed in this section. Following this discussion is a description of the independent variables according to their function in the analyses. Details regarding measurement of variables in grouped versus institutional models are also discussed. Methodology, with regard to model specification, design, and analytical technique, is addressed in a third section. In particular, the three

stages of analysis and the general functional form of the models used in this research are described in this section. The chapter concludes with some general comments on specific methodological concerns.

## Measurement of Demand

One of the most difficult problems in this research was determining an appropriate measure of the demand for higher education. Earlier research has tended to focus on actual enrollment alone or enrollment relative to the total pool of potentially eligible students. Unfortunately this index is not appropriate in some states due to the imposition of enrollment caps on public institutions. As a result, the supply for many institutions is limited by factors beyond the influence of tuition and fees. In addition, the acceptance of students for enrollment is often based upon academic and other noneconomic factors. These two circumstances combine to create a situation similar to that illustrated in figure 1. In this situation, the lack of enrollment caps would result in a potential enrollment and price level as represented by point "a", assuming all other enrollment restrictions such as academic standards are held constant. However, given the need to restrict size, an institution may use price to control enrollment levels while maintaining current academic/admissions standards in order to preserve the diverse composition of its student population (see point "b"). Use of price for this purpose, of course, depends upon the responsiveness of enrollment to

changes in price. If enrollment is not sufficiently responsive to price, the institution then must use non-price restrictions and thus would not be operating on the curve shown in figure 1.

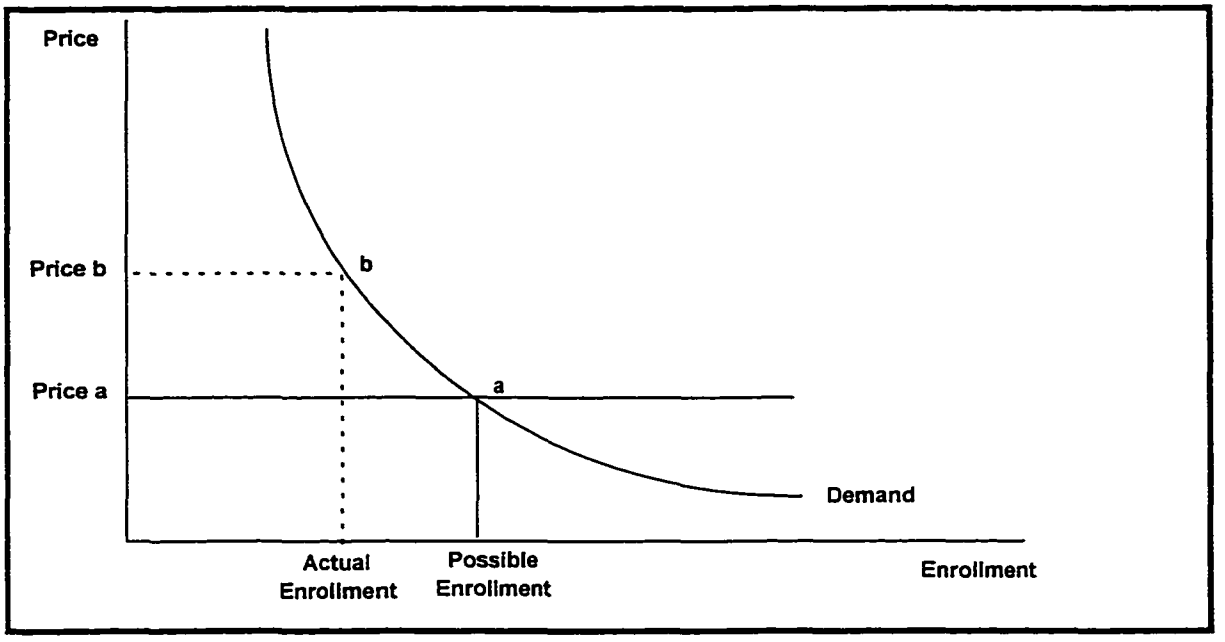


Figure 1. Results of Enrollment Ceiling

A second concern was the desire to examine the influence of price and other cost factors on demand. In the case of cross-sectional analysis, this desire required that several institutions, which were similar in character, but had different cost factors, be considered simultaneously to achieve adequate variation in price. Both the problem with enrollment caps and the problem of

grouping institutions can be greatly diminished by dividing the enrollment from a given municipality in a specific institution by the total entering freshmen enrollment for that institution. Since this study considered North Carolina resident, or in-state, enrollments only, the beginning freshman enrollment in an institution from a given municipality was divided by the total number of beginning in-state freshmen at that institution.

Measurement of the dependent variable, or demand, in this manner was based on two assumptions. First, the proportion of students enrolled in public four-year institutions from a specific locality was assumed to be linearly related to the proportion who would have enrolled given a lack of enrollment and/or admissions constraints (i.e., a constant acceptance-to-application relationship). In other words, if all applicants from all municipalities were equally acceptable to an institution, then this measure estimated the point on the demand curve which would have been obtained if there were no cap on enrollments, all other things being equal. The assumption of a lack of nonprice rationing has both theoretical and empirical support in the literature (Blaug, 1966; Corazzini et al., 1972; Hopkins, 1974; and Schultz, 1961).

The second assumption was that all the institutions were equally desirable to the applicants (i.e., a constant enrollment-to-acceptance relationship). In this regard, the demand ratio not only estimates the proportion of high school graduates from a municipality who were applicants to a given institution but also

took into account the varying sizes of the different institutions. Of course, both of these assumptions do not strictly hold as is discussed by Radner and Miller (1975) and Kohn, Manski, and Mundel (1974). Research efforts by these individuals focused on the process of student choice and necessarily depended upon more unique, complex data analysis methods than applied in the current research. In fact, the analyses conducted for this research were a logical first step in the attempt to study student choice patterns, admittedly a refined or specialized area of student demand analysis.

The intent underlying the formulation of the dependent variable was to estimate some linear function of the number of students who would have enrolled had there not been an enrollment ceiling on each institution. The assumptions outlined above allow that if, in fact, the institutions in a given subgroup were very similar, then the number of students who would have entered each would be the same given the institutions were all the same size. Furthermore, when institutions were not the same size, the number of students these colleges accepted would be proportional to their number of beginning freshmen enrollment. In other words, if two institutions, one having a freshmen class twice the size of the other, enrolled the same number of students from a particular locality, then the varying proportions of total enrollment derived from this locality for these two institutions would reflect varying levels of demand. On the other hand, if one were to use only the number of enrollments by locality or

the ratio of enrollments to high school graduates by locality, then there would appear to be no difference in the demand dependency of these two institutions on the locality in question. It is obvious that all institutions are not equally desirable, even when homogeneous groups are formed. At the same time, it was believed that the error made in this assumption was substantially less serious than the erroneous conclusions which would have been drawn if the adjustment for size had not been made, particularly in the context of nonprice limits on enrollments.

For these reasons, the measure of demand derived for use in this study was closer to the true measure than the one which would have been obtained by dividing local enrollment by the total pool of potentially eligible students. Moreover, by using a research design which allowed the observation of demand within the context of a given type of institution, the differential impact of alternative institutions on student demand was demonstrated. The joint dependence of demand on different types of institutions or other post-high school alternatives (Radner & Miller, 1975; and Kohn et al., 1974), however, was not reflected in the current research. Besides providing a more appropriate measure of demand for this research, relative to traditional measures used in past research, the demand measure as defined in this section standardized institutions of different sizes such that they could be analyzed in the same group. Calculation of the criterion in this manner prevented factors of supply from being

confounded with demand in the regression weights, a concern predominant among earlier longitudinal studies (Campbell & Siegel, 1967; Hight, 1975; and Hoenack & Weiler, 1975).

In summary, the dependent variable (E) was measured as the ratio of the number of students from a specific municipality enrolled as first-time entering freshmen at a particular institution to the total in-state, first-time entering freshmen enrollment for that same institution. Use of this criterion alleviated the problem of enrollment caps and allowed the standardization of institutions of different sizes such that selected institutions could be grouped and price variation achieved.

## Independent Variables

The independent variables selected for this analysis were grouped according to their function in the models. Briefly, with respect to the five classifications of determinants used in this research, these variables included: (1) eligible population--the number of high school graduates or the total population of potential enrollees; (2) educational background--the average ability of prospective students and the educational attainment of adults within the students' environment; (3) family income--the ability of different income groups to finance a college education; (4) direct/indirect costs--cost of college attendance, opportunity cost and employment opportunity; and (5) county characteristics--the

environmental influence of different local characteristics on enrollment demand. These variables are discussed in greater detail below.

Few studies have employed the eligible (consumer) population factor as an independent variable because, typically, this factor was used as the denominator in the enrollment or demand ratio. The measure of eligible population used in this study was the number of high school graduates (HSSG) for each municipality. Hoenack (1968) included this factor among the independent variables in his regression analysis, using as the dependent variable a ratio much like that used in this research. It was the use of such a criterion variable that brought about favorable review of Hoenack's work in contrast to other enrollment demand studies (Radner & Miller, 1975). Because demand is dependent on the size of its relevant population, this factor is a necessary variable in analyses based on the demand dependency of various institutional types. Eligible population was expected to bear positively on enrollment.

The educational background factor involved two variables: average ability score (North Carolina Competency Test--NCCT) and educational attainment level,(EDUL). NCCT was measured by the average NCCT score for 1995 seniors (see appendix for further details on measurement of variables). The NCCT variable was used to reflect not only the students' ability to overcome any nonprice rationing that might have existed via college admissions policies, but

also the students' probable expected return from a college education. Moreover, as in previous studies, student ability also served as a proxy for students' tastes and preferences for higher education. Similar variables have been included in the research of Feldman and Hoenack (1969), Corazzini et al. (1972), Spies (1973), Hopkins (1974), Hoenack and Weiler (1975), Bishop (1977), Chapman (1979), Radner and Miller (1975), and others. Theoretical support for use of ability variables comes from Blaug (1966) and Becker (1975) who noted that the higher the students' ability the less their risk in investing their resources (monetary and nonmonetary) in higher education.

Educational attainment (EDUL) was measured as the proportion of adults in the students' locality who had completed one or more years of college. Although its function primarily was to indicate the influence of the students' environment on their propensity or taste for higher education, this variable also was used as a proxy for family income. Several studies have recognized this joint function of educational attainment (Corazzini et al., 1972; Hoenack, 1968; Hopkins, 1974; and Tannen, 1978). Hoenack (1968) recognized the value of including educational attainment in his analysis but was forced to exclude it from his models due to its high correlation with income. Hopkins (1974) included this variable along with an income variable in his analysis; both were found significant in the case of public enrollments nationwide. However, the income factor became nonsignificant in his total enrollment function where private

enrollments were also included. Educational attainment and price were identified as the strong influences on total demand. Notwithstanding these mixed results, educational attainment was recognized as a relevant factor and was thus included in this research.

Income, of course, relates to the students' ability to finance their investment. Many studies have included median or disposable family income as the measure of income in their analysis (Campbell & Siegel, 1967; Hopkins, 1974; and Hight, 1975). Others have stratified their data by income levels, intending to examine the distributional effects of income on enrollment demand (Corazzini et al., 1972; Feldman & Hoenack, 1969; Hoenack, 1968; Kohn, et al., 1974; Radner & Miller, 1975: and Spies, 1973). Some (Feldman & Hoenack, 1969; Spies, 1973; and Radner & Miller, 1975) further stratified by income/ability groups based on the premise that the higher the ability to finance an education as well as the ability to succeed, the greater the expected rate of return to education and, hence, the tendency to enroll.

The lack of data on individual students prevented such analysis in this research. In an attempt to account for distributional effects, income was measured as the proportion of households within four EBI (effective buying income) groups (CATA, CATB, CATC, CATD). Assuming these proportions represented the distribution of high school graduates across different income levels, it was proposed that membership in lower or higher income groups would

demonstrate the distributional effects of income on enrollment demand. Unfortunately, coefficients for these measures proved to be insignificant and generally uninterpretable. Examination of the intercorrelations of these variables with each other and with other measures in the model evidenced a high degree of collinearity--thus, the EBI ranges were dropped from the model. Instead, a measure of local median income (INCOME) was included in the grouped models. An interaction term between this variable and PRICE also was examined; however, results from this specification proved to be insignificant.

For the individual institutional models, no separate measure of income was included in the general model. Rather, a measure of the budget constraint (BUDCON); i.e. financial burden, was used in these models and results were discussed in the cost factors section. Since this variable was a ratio of PRICE to INCOME, the inclusion of a separate measure of INCOME produced high variance inflation factors for both the PRICE and INCOME variables (Belsley, Kuh, & Welsch, 1980). Also, due to the high correlation between EDUL and INCOME, it was determined that EDUL could jointly serve as a measure of the effects of educational attainment and as a proxy for family income effects.

The cost factor was divided into direct and indirect costs. Direct cost (PRICE) was measured as the tuition and required fees plus living expenses depending on whether or not a given locality was determined to be within "reasonable" commuting distance of an institution. The commuting range was

thirty (30) miles, excepting those students who live in the local vicinity with relatives. Otherwise, the commuting range was fifty (50) miles. Similar distances or consideration of reasonable commuting distances were addressed in Hoenack (1968), Bishop (1977), and Kohn, et al. (1974). This variable also had some characteristics of a proximity measure, since for any given institution the PRICE was substantially lower for those within commuting distance. If the geographic center for a region was beyond the commuting distance, the direct cost (PRICE) for an institution included living expenses. Thus, tuition, fees, and living expenses (where appropriate) introduced the price variable included in typical demand analyses and also allowed some reference to proximity.

A problem, of course, arose when attempting to include a cost factor in models developed for individual institutions. Use of a cross-sectional design resulted in limited variation in the PRICE factor for any given institution. Consequently, this factor was not included in the analysis of enrollment demand for single institutions. However, an alternative measure successfully used by Radner and Miller (1975) was adopted. This measure (BUDCON) reflected the average "financial burden" of attending college and was measured as the ratio of direct costs to income, or PRICE to INCOME.

Indirect costs were measured as the average local wage of production workers (WAGE) and the local unemployment rate (URATE). The wage rate (measured in thousands) served to indicate the loss of income incurred due to

enrollment in higher education--a variable familiar to us as the opportunity cost. The unemployment rate indicated the probability of employment given one was in the labor force. Use of these variables has yielded contrasting results in past research. Hoenack (1968) found wage rate to be significant and unemployment rate insignificant, suggesting that although California students placed value on their time which was at least as high as the current wage rate, unemployment rates were unrelated to enrollments. Corazzini et al. (1972), however, found wage rates to be insignificant and unemployment rates significant. Both variables did exhibit the greatest impact on low income/low ability groups in the two studies. Such results have been attributed to a confluence of effects between the two factors--a negative cost effect due to foregone earnings, and a positive income effect in terms of current part-time employment opportunities. It may be that inclusion of both factors is unnecessary, a conclusion partially supported through the results of this study.

The last set of determinants included measures of county characteristics, see appendix for complete list of counties in North Carolina. These measures were used to reflect the tastes or preferences of students with regard to college enrollment. Several studies have incorporated a variety of environmental or geographic variables to explain differences in enrollment demand. Tannen (1978) found that regional dummy variables demonstrated differences in attitudes toward education or the advantages of having a concentration of

schools nearby such that it enhanced enrollment rates in affected regions. Feldman and Hoenack (1969) included both regional dummy variables and variables denoting the urban-rural character of a locality. Use of the latter was based on evidence that persons' urban-rural background affects their rate of return to a college education, the urban students realizing a greater return (Becker, 1975). Although such measures have not proved significant in many cases, their impact was considered in this research.

County characteristics were measured as the proportion of income generated via different industrial sectors. These sectors included: (1) AGIND--natural resource industries such as agriculture and mining; (2) MFGIND--other nonnatural resource industries such as construction and manufacturing; and (3) SVCIND--support industries such as transportation, trade, finance, and service corporations. Since the proportions totaled to unity for any given locality, only two sectors could be included in the models if sensible estimates of the county characteristics effect were to be obtained. However, in the models developed for this research, only the AGIND sector was included. There were two reasons for this approach. First, the two remaining sectors were found to contribute almost equally to the demand function; therefore, separate estimation of their effects rather than that for AGIND was not warranted. Secondly, intercorrelations between MFGIND and SVCIND and other factors evidenced a high degree of collinearity, further warranting exclusion of these variables. It was assumed that

the AGIND sector represented the rural-related characteristics of a locality and, hence, would be negatively related to enrollment.

## Methodology

Due to a lack of continuous data for all variables comprising each set of determinants and the possibility of confounding supply and demand via the longitudinal approach, a cross-sectional design was employed in this research. The design was cross-sectional in that it incorporated data for one point in time across several higher education institutions within one state (North Carolina) system. Although there are distinct advantages and disadvantages in employing this approach, use of it has been widespread in similar studies (Bishop, 1977; Corazzini et al., 1972; Feldman & Hoenack, 1969; Hoenack, 1967; Hoenack & Weiler, 1975; Hopkins, 1974; Kohn, et al., 1974; Radner & Miller, 1975; and Tierney, 1980).

As indicated earlier, the primary purpose for using the cross-sectional design was to diminish the identification problem. In this research, demand was assumed to be a function of price, income, academic ability, and other previously discussed factors. When such factors are examined over time, variation in the different factors may be associated not only with variations in demand, but also with variations in supply (i.e., an identification problem). The latter consequence would require specification of supply factors and the interactions between supply

and demand. Such analyses were beyond the scope of this research. Using the cross-sectional design, the supply of enrollment places was assumed constant, allowing regression coefficients to reflect only parameters of demand.

Another noted advantage in using a cross-sectional design rather than a longitudinal or time series design is that there is less bias among the independent variables. In at least one instance it was found that due to the high correlation between tuition charges over time, the use of cross-sectional rather than time-series data was the most appropriate for enrollment predictions, or for estimating the effect of changes in various determinants on higher education enrollments (Hoenack & Weiler, 1975). The disadvantage of using a cross-sectional approach involves the lack of variation in some variables. For instance, the cost of attendance at community colleges in North Carolina lacks variation because it is the same for all North Carolina community colleges in a given year. As a result, the effect on enrollment of the community college alternative is difficult to examine using a cross-sectional design; and consequently, was not included in this analysis.

The lack of information on individual students required the use of an aggregate data base where the unit of analysis was the locality (county or city) from which students enrolled. Several studies have used similar units of analysis. Campbell and Siegel (1967), Hight (1975), Hopkins (1974), and Tannen (1978) used data aggregated at the state level in their separate

nationwide analyses of educational demand. Although Corazzini et al. (1972) had individual student data available, they based their analysis on statewide averages of these data. Similarly, Hoenack (1968) compiled individual data to create aggregate measures at the high school district level. However, both Corazzini et al. and Hoenack were able to stratify their data by income level due to the availability of their data at the individual student level. This stratification allowed these researchers to examine the distributional effects of income on enrollment demand.

Other studies (Bishop, 1977: Hoenack & Weiler, 1975; Radner & Miller, 1975; and Spies, 1973) have been based on individual student data, seeking to examine individual demand for higher education at various stages of the enrollment process by several classifications of student type, institutional type, or other classification schemata. While this level of detailed analysis may be preferred in many cases, the lack of individual data on North Carolina students prevented such analysis in this research. Furthermore, since the purpose of this study was directed toward statewide enrollment planning efforts, it was more appropriate to focus on demand at the macro level by the average individual rather than on demand at the micro level by the unique individual. It is recognized, however, that the use of aggregate data raised the possibility of measurement error, particularly with regard to student related factors such as ability and family income.

Multiple linear regression was used to analyze the data across three stages of investigation. In the first stage, a regression model was developed for the statewide group of public, four-year institutions (see appendix for a list of these institutions). This model reflected the net effect of each determinant on enrollment across all types of institutions. In other words, possible differential effects for the variables across various types of institutions were not evident in these results. Institutional groupings were used in the second stage of analysis to examine this possibility. The second stage of analysis examined enrollment demand within three institutional groupings (see appendix C).

These groupings were selected in an attempt to investigate enrollment determinants within the context of more homogeneous groups of institutions; satisfying, in part, the assumption of equally desirable institutions for a given pool of students. The first group represented the traditional, comprehensive universities that offer professional, doctoral, and other graduate level programs, as well as an extensive research component. The second group consisted of those institutions which were schools that concentrated their curriculums primarily in liberal arts programs. The third group shared the distinction of being located in close proximity to large metropolitan areas, as well as having a similar curriculum of liberal arts, professional or occupational programs, and some graduate work.

In the third stage of analysis, separate regression models were produced for each individual four-year institution. The general functional form of these models necessarily differed from that used for the grouped institutional models due to the limited variability in price, or tuition and fees, for any one given institution. In regard to the economic related determinants, the effect of financial burden (BUDCON) on enrollment replaced both income and direct cost factors since (1) these factors were used to construct the BUDCON variable; (2) the variation for direct cost was limited; and (3) the income factor was approximated by the educational attainment variable for the institutional models. Determinants related to noneconomic and environmental factors were examined not only in the context of their effect on a given institution's enrollment, but also in regard to their differential effects across institutions. In brief, fifteen linear regression models were produced in stage three--one for each four-year institution--to examine the effects of income, financial burden, and other factors on institutional enrollment demand.

Using data to reflect a 1995-1996 time frame, the enrollment models were developed by regressing the enrollment ratio (demand measure) on the explanatory variables representing the five sets of determinants as described above. The general functional form of the models used in the analyses for

stages one and two was:

$$\log E = b_0 + b_1 \log HSSG + b_2 NCCT + b_3 EDUL +$$
$$b_4 \log INCOME + b_5 \log PRICE + b_6 WAGE +$$
$$b_7 URATE + b_8 AGIND$$

Models developed in stage three of this research had the following general form:

$$\log E = b_0 + b_1 \log HSSG + b_2 NCCT + b_3 EDUL +$$
$$b_4 \log BUDCON + b_5 WAGE + b_6 URATE +$$
$$b_7 AGIND$$

## Comments on Methodology

A cross-sectional design was used in this research. Therefore, it is important to remember that the results of these analyses do not reflect transition, or the effects of shifts in the independent variables on the dependent variable. The models estimated direct effects only and were not used to postulate future effects. Therefore, changes in specific variables were interpreted in terms of the context in which they were set. For instance, a change in PRICE was discussed in terms of: "if price had been this, then the enrollment rate might have been this"--rather than "if price is this, then the enrollment rate will be this".

Three additional methodological issues concerned the use of a general functional form model across each grouping and/or institution in the three stages

of analysis, the use of logged variables, and the degrees of freedom for testing the regression coefficients obtained across the three stages of analysis. For the first issue, it was recognized that if the models developed and included in the formal analysis of this study had not been restricted to a general functional form, the resultant models could have been quite different not only from the general model but also from other grouped or institutional models. While such models may have been more representative of the effects of explanatory factors on enrollment within a given context, they would not have allowed comparison of these effects across different groupings or different institutions. One of the objectives of this research was to examine the differential effects of factors across institutions; therefore, only the results for models developed with regard to a general functional form were discussed.

The second issue concerned the inclusion of logged variables. One use of logged, independent variables was based upon the desire to produce estimates of constant elasticity for the economic factors, specifically the price and income variables. By logging these variables, direct estimates of the elasticity of these factors were obtained from the regression weights; otherwise, use of unlogged variables would have required the manual transformation of resultant regression coefficients into elasticity coefficients. Furthermore, the resulting estimates of elasticity obtained from unlogged variables would not be constant, for they would vary as a function of the point at which they were

estimated. Elasticity coefficients provide information not only with regard to the general responsiveness of enrollment to selected factors, but also provide an indication of the nature of enrollment demand with regard to these factors. Finally, use of constant elasticities are particularly useful, in that they are "unit-free" and the effects of the variables to which they apply may be expressed in terms of percentage changes (Pindyck & Rubinfeld, 1980). Specifically, as opposed to the form for the slope of unlogged independent and dependent variables ($B_i = \Delta y/\Delta x$), elasticities derived from double-log transformations are of the form ($B_i = (\Delta y/y)/(\Delta x/x)$). These characteristics facilitated examination of price and other economic factors across institution types.

Another use of logged variables concerned their effect on the overall efficiency of the model. Because much of the data being used in this research constituted "count" data, vital statistics, census data and so forth, many variables were better expressed in logarithmic form. In those cases where logging a variable increased the $R^2$ of the general model and/or improved the significance level of the variable within the model, then the log of that variable was used.

The variance and covariance for all variables except the direct cost variables (PRICE, BUDCON) were a function of the 136 localities in the state, with all localities being represented for each institution. Therefore, the degrees of freedom, or independent "n", for these variables should be 127 for stage one and two models and 128 for stage three models--where df=(N-k-1). However,

when institutions were grouped for stage one and two analyses, the locality by institution arrangement of the data increased the degrees of freedom for these variables to 399 for Group I and Group II models, to 535 for the Group III model, and to 2,031 for the statewide model. In other words, for each of the fifteen institutions, there were 136 observations--one for each county or city in the study. This increase in the degrees of freedom might affect the significance of t-values for the resultant coefficients. On the other hand, given the very slight change in magnitude of the t-values significant at the 0.05 and 0.01 levels of significance when the degrees of freedom equal 120 or more, the potential for error in this regard is minimized. Nevertheless, the reader should keep in mind the data configuration and the possible inflation in degrees of freedom when examining the results for models generated in stages one and two.

The analysis of higher education demand attempted in this research was descriptive in nature. The effects of different sets of enrollment determinants selected on the basis of the human capital investment approach were examined for a given statewide system of public, four-year colleges and universities. Results of this research were meant not only to provide information about the feasibility of this methodology with regard to examining the demand dependency of different types of institutions, but also to provide a base of research upon which subsequent research efforts could build. Differential effects evidenced with regard to the institutional groupings may lead to linkages with related

research efforts on, for example, pricing policies, student migration, growth management, or financial aid. Given the uncertain state of higher education enrollments, such information would be particularly important and necessary to the maintenance of a viable system of higher education.

# RESULTS AND FINDINGS

## Overview

This chapter presents enrollment demand models for three stages or levels of analysis: (1) statewide; (2) institutional type or subgroup; and (3) individual institution. Overall regression models for the different institutional groupings comprising stages one and two are presented in table 2; models for the individual institutions in stage three are presented in table 3. Results of separate analyses in each stage are discussed with respect to the five sets of determinants described in chapter three. Because the models in stages one and two have the same functional form, differential effects across models in these stages are addressed within the same section for a given set of determinants. Where differing effects occurred, explanations are proposed with respect to past research sample for each of the separate models, other variables included in the analysis, and/or possible methodological or theoretical problems evidenced with regard to development of the model. The reader is reminded of the degrees of freedom concern discussed in chapter three. Because each locality was crossed with each institution, the degrees of freedom for testing the resultant nonprice

coefficients may be artificially increased. However, the degrees of freedom for testing the resultant nonprice coefficients were believed to be slight if existent at all.

Results for the models developed in stage three are presented similarly in a separate section. The effect of the budget constraint (financial burden) variable (BUDCON), for instance, is examined across all models developed in stage three. These results, however, are not compared directly with those obtained in stages one and two due to the unique functional form of the models produced in stage three. Differential effects across models within stage three, of course, are identified and discussed in a manner similar to the discussion outlined above for stages one and two.

Where appropriate, particular attention is given to estimates of elasticity produced for the direct cost and budget constraint (financial burden) factors. Since the elasticity coefficients are unit-free, results are interpreted in terms of percentage change. In general, elasticities reflect the level or extent of responsiveness in the dependent variable with respect to the independent variable defining the type of elasticity (e.g., the elasticity coefficient associated with the price variable is referred to as "price elasticity"). Descriptive statistics for all variables included in the models are presented in tabular form in appendix D.

## Statewide and Institutional Group Analyses

### Eligible Population

The number of high school graduates by locality was a statistically significant determinant of enrollments across all institutional groupings. Table 4 contains the summary statistics for the three institutional types or groupings, and for the statewide grouping of all public four-year institutions.

The results indicate that an increase in the number of high school graduates across different localities did not lead to a proportionate increase in the number of students contributed to educational institutions. In other words, doubling the number of high school graduates was associated with more enrollees but significantly less than twice as many enrollees. These findings are consistent with previous research (Bishop, 1977; and Hoenack, 1968). They are also reasonable given the college bound rate of attendance for the entire state was about 57 percent.

### Educational Background Factors

The average ability score (NCCT) for graduating seniors and the proportion of adults (age 25 and over) who had completed some college work (EDUL) constituted the educational background factors for each locality. These results are shown in table 5.

Results for the educational background factors were mixed. It was initially believed that high ability levels for high school graduates in a locality would have a positive effect on the area's contribution ratio. An examination of the results in table 5 confirms that the effects were uniformly negative. Although the negative coefficients for NCCT were unexpected, such an outcome is not unprecedented. Feldman and Hoenack (1969), in their separate analyses of public, private, and total combined enrollments, found that public enrollment declined the higher the ability/ income level of the students. Findings of the current research suggest that higher ability graduates exhibited either a persistent tendency to "go away" to college or to substitute private for public enrollment. In other words, higher ability graduates in North Carolina might have enrolled in out-of-state institutions or private institutions to a greater degree than lower ability graduates, particularly if higher ability students also came from higher income backgrounds.

The second educational background factor, the proportion of adult residents within the locality who had attended some college, was found to have consistently positive and statistically significant effects on enrollment in North Carolina institutions. With regard to prior research, most studies have found educational attainment to be a significant, positive indicator of the tastes and preferences of students for higher education. Thus, the educational environment or preference measured by this factor had the expected result. However, the strong relationship between educational background and income produced

mixed results, perhaps partially accounting for the weak effect of income factors as incorporated in the grouped models.

Family Income Factors

Several measures of the family income factor were attempted in the institutional grouping analyses. Due to collinearity problems, measures reflecting distributional effects were dropped from the models, leaving simply a measure of median family income (log INCOME). There did not appear to be any significant effects, however, due to median income levels. Table 6 presents the results INCOME.

In general, the coefficients for INCOME were positive and non-significant, although that for the major universities (Group I) was negative. These mixed, weak effects might be due to the strong, positive relationship with the dependent variable than did INCOME. It appears that if income entered into the enrollment decision, it did so through the educational attainment factor and/or through an interaction with the direct cost variable.

Cost Factors

Three types of cost factors were used in these analyses: (1) the direct cost of attendance (log PRICE); (2) the indirect cost via opportunity costs (WAGES); and (3) the indirect cost via employment opportunities (URATE).

Statistical results pertaining to these cost factors are shown in table 7.

The direct cost of education, or PRICE, had the expected negative effect across all institutional groupings, with price elasticities ranging form a non-significant low of –0.154 for the major universities (Group I) to a statistically significant high of –1.802 for Group II. In other words, had PRICE had been 1.00 percent higher, enrollments might have been 1.80 percent lower at the institutions in Group II. Given the significance of these elasticities and the differential effects across institutional groupings, tuition and fees may be viewed as a viable instrument for rationing enrollments and for influencing distribution of enrollments across Group II and Group III institutional types.

Indirect cost measures were included in the models as opportunity cost and employment opportunity. Opportunity cost, or foregone earnings, was measured in thousands by the average manufacturing wage in locality (WAGES); employment opportunity was measured by the local unemployment rate (URATE). Observing table 7, coefficients for WAGES and URATE were not statistically significant for any of the institutional groupings. As in Hoenack's research (1968), expectations with regard to the sign of the coefficients for these two variables were not hypothesized due to a possible confluence of their effects. However, in the current research, the signs for the coefficients did tend to have a pattern, being negative for WAGES and positive for URATE for all groupings except Group II institutions. This pattern corresponds to a general

hypothesis advanced by some researchers (Bishop, 1977; Corazzini, 1972; Hoenack, 1968; Rusk, Leslie, & Brinkman, 1982; and Salley, 1977), where higher opportunity cost are presumed to increase the perceived costs of education, thus decreasing the tendency to invest or enroll, and higher unemployment is presumed to decrease the probability of current income, thus increasing the tendency for students to invest their time, at least, in continued education.

County Characteristics

Previous theoretical and empirical research led to the hypothesis that rural areas, where there are significant agricultural influences, may not contribute students to colleges to the same extent as urban areas. In other words, a negative relationship was presumed between demand for enrollment and the rural character of students' environment. For this study, the percent of income generated within each municipality was calculated for three broad sectors of industry: (1) AGIND—agricultural; (2) MFGIND—manufacturing; and (3) SVCIND—services. Since these percentages added to unity for each area, only one of the three was included in the models in order to obtain sensible estimates. The manufacturing (MFGIND) and service (SVCIND) industries were excluded since these factors were found to be highly collinear with other variables in the model. Also, earlier analysis revealed that these two sectors

contributed fairly equally to the demand function, eliminating the need to estimate their separate coefficients. Results for AGIND are shown in table 8.

All coefficients were statistically significant at the 0.02 level of significance or better, with the anticipated negative sign. As expected, the more rural the industrial character of the geographical area, the less was the contribution to college enrollment.

Explanatory Power of Statewide and Institutional Group Models

The ability of the general model to explain differences between area contribution rates can be evaluated by "goodness-of-fit" measures. These are shown in table 9.

In general, models using the ratio of institutional enrollment from a locality to an institution's total freshmen enrollment produced encouraging results. The multiple correlations were consistent with previous research efforts and seemed to be inversely related to the heterogeneity of the institutional types.

Descriptive statistics for all variables used in the stage one and two models are provided in tables 10 and 11. Table 10 shows the intercorrelations between the independent variables. It should be noted that this matrix is identical for all groupings of institutions including the individual institution models (except with regard to the PRICE variable) since the variance and covariance was a function of the 136 localities and all localities were represented for each

institution. It is interesting to note that in North Carolina, wealth, academic ability, educational attainment, and size (number of high school graduates) appeared to be positively related. The strong relationship between EDUL and INCOME suggests that one might be used as a proxy for the other, an approach used in stage three analyses. Table 11 presents the correlations between the independent variables and the dependent variable for each of the institutional groupings. In general, almost all of the independent variables were significantly correlated with the enrollment ratio. The one exception regards the PRICE variable for the major universities (Group I), which may have contributed to the lack of significance demonstrated by this variable in the Group I model.

## Individual Institution Analyses

### Eligible Population

The number of high school graduates from the different localities was a statistically significant determinant of enrollments for almost all institutions. Summary statistics for this coefficient across all institutions are contained in table 12. In general, a 1.00 percent increase in the number of high school graduates was found to be significantly associated with a low enrollment proportion gain of 0.20 percent for UNC-Charlotte and a high gain of 0.80 percent for North Carolina State University (NCSU). As expected, all coefficients were positive. For the two institutions where HSSG was not significant, the value of the coefficients was very low and, most likely, reflected the unique commuter status of North Carolina Central University and the particularly local, less populated, rural localities supporting UNC-Pembroke's student base.

### Educational Background and Income Factors

The average ability score (NCCT) and educational attainment level (EDUL) were the two measures of educational background included in these analyses. Results for these two measures are shown in table 13. As with the institutional grouping analyses, unexpected results with regard to NCCT were evidenced. In general, coefficients for average ability were negative, indicating

that enrollments were lower given higher ability levels across localities. In most instances, statistically significant effects were associated only with negative NCCT coefficients- UNC-Greensboro was the only case where a positive coefficient was found to be statistically significant. Moreover, four of the seven institutions having negative, significant NCCT coefficients were located in urban areas. The instability of NCCT coefficients with regard to sign in this stage of analysis most likely reflects results of collinearity in that NCCT tended to be highly correlated with EDUL and/or BUDCON for many institutions, and positively related to both EDUL and HSSG across all institutions. Each of these measures, EDUL, HSSG, and BUDCON, proved to have a higher correlation with the criterion than did NCCT for most institutions. The ability measure, therefore, might have served as a suppresser variable in some models, or might have been collinear with other variables in the model such that its relatively weaker relation with the criterion produced unstable coefficients.

The educational attainment level of the locality proved to be a primarily positive influence on enrollment rates. The one negative coefficient for UNC-Greensboro was statistically nonsignificant. Effects for this factor were particularly strong among the Group I and Group III institutions, suggesting that, in general, these institutions depended more heavily on localities where higher educational backgrounds were evidenced than did other institutions. In addition, the educational background factor served as a proxy for income levels in this

stage of analysis. Thus, according to the results in table 13, higher proportions of institutions' total freshmen enrollments were associated with higher income levels across North Carolina localities. This positive effect was statistically significant for nine out of fifteen institutions, and agrees with prior research measuring income and educational background factors in this manner.

Cost Factors

Direct and indirect cost factors were included in this analysis. Direct costs in this stage of analysis were approximated through a ratio of PRICE, tuition and fees plus living expenses where appropriate, to INCOME, median family income by locality. The resultant measure (log BUDCON) represented the financial burden of attending North Carolina's four-year public institutions for students within each locality. Use of this measure was necessary due to the limited amount of variation in PRICE for individual institutional models based on cross-sectional data. Indirect costs were measured by WAGES, or foregone earnings, and URATE, the unemployment rate. Results for these factors are presented in table 14.

Coefficients for BUDCON were uniformly negative for all but two institutions, where the positive effects were not statistically significant. Financial burden effects were statistically significant for all institutions but those comprising the major universities (Group I) and one special purpose institution, North

Carolina School of Arts (NCSOA) . The former agrees with those results obtained in the analyses by institutional groupings. With regard to the positive but statistically nonsignificant coefficient for NC School of Arts, it appears that for a special purpose institution of this type, factors other than costs were the more important determinants of enrollments. In general, for those institutions showing significant effects for BUDCON, a 1.00 percent increase in BUDCON in 1995, be it due to an increase in PRICE or a decrease in INCOME, was associated with anywhere from a 1.40 percent lower enrollment proportion (on the average) at Winston Salem State University (WSSU) to a 0.06 percent lower enrollment rate at UNC-Pembroke.

Few statistically significant effects were produced with regard to indirect cost measures. In general, opportunity costs (WAGES) tended to have a negative effect on enrollment, while unemployment rates tended to be positively associated with enrollment. In other words, the costs of attendance in terms of foregone earnings appeared to influence college enrollments negatively, while increases in unemployment rate tended to influence prospective students to invest their time, at least, in college while awaiting better employment opportunities.

County Characteristics

The rural versus urban character of a locality was reflected in the level of

income generated by various sectors of industry. As in the institutional grouping analyses, the level of economic activity via the agricultural industries (AGIND) was used to designate the rural character of the localities from which institutional enrollments originated. Regression results for this factor are shown in table 15. Signs for AGIND coefficients were negative for all but three institutions. In other words, the more rural the locality, the less likely an institution depended on this locality for enrollments. Negative effects were statistically significant for seven institutions.

Of the three institutions showing positive effects, AGIND coefficients were not statistically significant for NC School of Arts (NCSOA) or UNC-Charlotte. The other institution showing a positive AGIND effect was UNC-Pembroke. This institution is located in Robeson County in the south central part of the state—an area heavily dependent on agriculture. The size of the coefficient and its strong statistical significance suggest that UNC-Pembroke was highly dependent on enrollments from this part of the state, at least. The effect for UNC-Pembroke was indicated earlier with regard to the HSSG variable.

Explanatory Power of Institutional Models

Summary statistics with regard to "goodness-of-fit" measures for the general model used this stage of analysis are presented in table 16. Multiple correlations ranged from a low of 0.280 at NCCU to a high of 0.633 for NCSU.

The general model, however, appeared to describe enrollments better for the Group III institutions as a group than for other types of institutions. It was least effective with regard to the one commuter college; namely, North Carolina Central University (NCCU).

Correlation tables for the dependent variable and the independent variables are presented in table 17. Also, since the variance and covariance of BUDCON depended on the particular institution for which it was measured, intercorrelations for BUDCON and the remaining independent variables are given in table 17 along with the correlations between the dependent variable (log E) and the independent variables. Intercorrelations between the remaining independent variables are the same as those shown in table 10 due to the dependence of all models on the variance/covariance evidenced across the 136 localities.

## Alternative Methodology Analyses

In the current research, logarithmic transformations were utilized for several measures since they produce constant elasticities for the related factors. There are alternative methodologies to this approach. Pindyck and Rubinfeld (1981) discuss some of these alternatives which include the Probit Model and Logit Model.

One such alternative approach is to assume that we have a regression model:

$$y_i^* = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + u_i \qquad \text{Equation (1)}$$

where $y_i^*$ is not observed. It is commonly called a "latent" variable. What we observe is a dummy variable $y_i$ defined by

$$y_i = \begin{cases} 1 & \text{if } y^* > 0 \\ 0 & \text{otherwise} \end{cases} \qquad \text{Equation (2)}$$

The probit and logit models differ in the specification of the distribution of the error term u in equation (1). The difference between the specification (equation 1) and the linear probability model is that in the linear probability model we analyze the dichotomous variables as they are, whereas in equation (1) we assume the existence of an underlying latent variable for which we observe a dichotomous realization. For instance, if the observed dummy variable is whether or not the person is attending college, $y_i^*$ would be defined as "propensity or ability to find an acceptable college." Similarly, if the observed dummy variable is whether or not the person has obtained higher education, then $y_i^*$ would be defined as "desire or ability to get a higher education." Note that in both the examples given, there is "desire" and "ability" involved. Thus the explanatory variables in equation (1) would contain variables that explain both these elements.

Note from equation (2) that multiplying $y_i^*$ by any positive constant does not change $y_i$. Hence, if we observe $y_i$, we can estimate the $\beta$'s in equation (1) only up to a positive multiple. Hence, it is customary to assume var $(u_i) = 1$. This fixes the scale of $y_i^*$. From the relationships equation (1) and equation (2) we get

$$P_i = \text{Prob}\,(y_i = 1) = \text{Prob}\;\; u_i > -\left(\beta_0 + \sum_{j=1}^{k}\beta_j x_{ij}\right)\Bigg]$$

$$= 1 - F \;\; -\left(\beta_0 + \sum_{j=1}^{k}\beta_j x_{ij}\right)\Bigg]$$

where F is the cumulative distribution of u.

If the distribution of u is symmetric, since 1 - F(-Z) = F(Z), we can write

$$P_i = F \;\; -\left(\beta_0 + \sum_{j=1}^{k}\beta_j x_{ij}\right)\Bigg] \qquad \text{Equation (3)}$$

Since the observed $y_i$ are just realizations of a binomial process with probabilities given by equation (3) and varying from trial to trial (depending on $x_{ij}$), we can write the likelihood function as

$$= \prod_{yi=1} P_i \prod_{yi=0}(1-P_i) \qquad \text{Equation (4)}$$

The functional form for *F* in equation (3) will depend on the assumption made about the error term u. If the cumulative distribution of (u) is logistic, we have what is known as the logit model. In this case

$$F(Z_i) = \frac{\exp(Z_i)}{1+\exp(Z_i)} \qquad \text{Equation (5)}$$

Hence

$$log\ \frac{F(Z_i)}{1-F(Z_i)} = Z_i$$

Note that for the logit model

$$\log \frac{P_i}{1-P_i} = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij}$$

The left-hand side of this equation is called the *log-odds ratio*. Thus the log-odds ratio is a linear function of the explanatory variables. For the linear probability model it is $P_i$ that is assumed to be a linear function of the explanatory variables.

If the errors ($u_i$) in equation (1) follow a normal distribution, we have the *probit* model. In this case

$$F(Z_i) = \int_{-\infty}^{Z_i/\sigma} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{T^2}{2}\right) dt \qquad \text{Equation (6)}$$

Maximization of the likelihood function (equation 4) for either the probit or the logit model is accomplished by nonlinear estimation methods.

The likelihood function (equation 4) is concave (does not have multiple maxima), and hence any starting values of the parameters would do (Pratt, 1981). It is customary to start the iterations for the logit and probit models with the estimates from the linear probability model.

Since the cumulative and the logistic distributions are very close to each other except at the tails, we are not likely to get very different results using equation (5) or equation (6), that is, the logit or the probit method, unless the samples are very large (so that we have enough observations at the tails). However, the estimates of the parameters $\beta_i$ from the two methods are not directly comparable. Since the logistic distribution has a variance $\pi^2/3$ , the estimates of $\beta_i$ obtained from the logit model have to be multiplied by $\sqrt{3}/\pi$ to be comparable to the estimates obtained from the probit model (where we normalize $\sigma$ to be equal to 1).

Amemiya (1981) suggests that the logit estimates be multiplied by 1/1.6 = 0.625 instead of $\sqrt{3}/\pi$, saying that this transformation produces a closer approximation between the logistic distribution and the distribution function of the standard normal. He also suggests that the coefficients of the linear probability model $\hat{\beta}_{Lp}$ and the coefficients of the logit model $\hat{\beta}_L$ are related by the relations:

$\hat{\beta}_{Lp} \approx 0.25\hat{\beta}_L$ except for the constant term

$\hat{\beta}_{Lp} \approx 0.25\hat{\beta}_L + 0.5$ for the constant term

Thus if we need to make $\hat{\beta}_{Lp}$ comparable to the probit coefficients, we need to multiply them by 2.5 and subtract 1.25 from the constant term.

Alternative ways of comparing the models would be:

1. To calculate the sum of squared deviations from predicted probabilities.

2. To compare the percentages correctly predicted.

3. To look at the derivatives of the probabilities with respect to a particular independent variable.

As an example, consider the data on a sample of 1500 enrollment applications in North Carolina. There were 996 student applications accepted and 504 student applications rejected. We define

$$y = \begin{cases} 1 & \text{If the student's application was accepted} \\ 0 & \text{If the student's application was rejected} \end{cases}$$

Three models were estimated: (1) the linear probability model, (2) the logit model, and (3) the probit model. The explanatory variables were:

AI = Income of parents of applicant ($10^3$ dollars)

DMP = total debt minus monthly payment ($10^3$ dollars)

DF = dummy variable, 1 for female, 0 for male

DR = dummy variable, 1 for nonwhite, 0 for white

DS = dummy variable, 1 for single, 0 otherwise

DA = age of student ($10^2$ years)

CNWP = percent nonwhite in the county ($x10^3$)

CMFI = county mean family income ($10^3$ dollars)

CA = county average age of students ($10^2$ years)

One can compare these models by observation of the $R^2$'s. The three sets of data reported in the tables are not much different from each other. The results are presented in appendix D.

Measuring Goodness of Fit

There is a problem with the use of conventional $R^2$-type measures when the explained variable y takes on only two values (Maddala, 1988). The predicted values $\hat{y}$ are probabilities and the actual values y are either 0 or 1. For the linear probability model and the logit model we have $\sum y = \sum \hat{y}$, as with the linear regression model, if a constant term is also estimated. For the probit model there is no such exact relationship although it is approximately valid.

There are several $R^2$-type measures that have been suggested for models with qualitative dependent variables. In the case of the linear regression model, they are all equivalent. However, they are not equivalent in the case of models with qualitative dependent variables.

The following are some $R^2$-type measures:

1. $R^2$ = squared correlation between y and $\hat{y}$.

2. *Measures based on residual sum of squares.* For the linear regression model we have

$$R^2 = 1 - \left[ \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \right]$$

We can use this same measure if we can use $\Sigma^n_{i=1} (y_i - \hat{y}_i)^2$ as the measure of residual sum of squares. Effron (1978) argued that we can use it.

Note that in the case of a binary dependent variable

$$\Sigma(y_i - \bar{y})^2 = \Sigma y_i^2 - n\bar{y}^2 = n_1 - n\left(\frac{n_1}{n}\right)2 = \frac{n_1 n_2}{n}$$

Hence Effron's measure of $R^2$ is

$$R^2 = 1 - \frac{n}{n_1 n_2}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$$

Amemiya (1981) argues that it makes more sense to define the residual sum of squares as

$$\sum_{i=1}^{n}\frac{(y_i - \hat{y}_i)^2}{\hat{y}_i(1-\hat{y}_i)}$$

that is, to weight the squared error $(y_i - \hat{y}_i)^2$ by a weight that is inversely proportional to its variance.

3. *Measures based on likelihood ratios.* For the standard linear regression model,

$$y = \beta_0 + \sum_{i=1}^{k} \beta_i x_i + u \qquad u \sim IN(0,\sigma^2)$$

let $L_{UR}$ be the maximum of the likelihood function when maximized with respect to all the parameters and $L_R$ be the maximum when maximized with the restriction $\beta_i = 0$ for i = 1, 2,...,k. Then

$$R^2 = 1 - \left(\frac{L_R}{L_{UR}}\right)^{2/n}$$

One can use an analogous measure for the logit and probit model as well. However, for the qualitative dependent variable model, the likelihood function (equation 4) attains an absolute maximum of 1. This means that

$$L_R \leq L_{UR} \leq 1$$

or

$$L_R \leq \frac{L_R}{L_{UR}} \leq 1$$

or

$$L_R^{2/n} \leq 1-R^2 \leq 1$$

or

$$0 \leq R^2 \leq 1 - L_R^{2/n}$$

Hence Cragg and Uhler (1970) suggest a pseudo $R^2$: (It lies in [0,1])

$$\text{pseudo } R^2 = \frac{L_{UR}^{2/n} - L_R^{2/n}}{1 - L_R^{2/n}}$$

Another measure of $R^2$ is that of McFadden (1974), who defines it as

$$\text{Mc Fadden's } R^2 = 1 - \frac{\log L_{UR}}{\log L_R}$$

However, this measure does not correspond to any $R^2$ measure in the linear regression model.

4. Finally, we can also think of $R^2$ in terms of the *porportion* of correct predictions. Since the dependent variable is a zero or 1 variable, after we compute the $\hat{y}_i$ we classify the *ith* observation as belonging to group 1 if $\hat{y}_i > 0.5$ and classify it as belonging to group 2 if $\hat{y}_i < 0.5$. We can then count the number of correct predictions. We can define a predicted value $\hat{y}_i^*$, which is also a zero-one variable such that

$$\hat{y}_i^* = \begin{cases} 1 \text{ if } \hat{y}_i > 0.5 \\ 1 \text{ if } \hat{y}_i < 0.5 \end{cases}$$

(Provided that we calculate $y_i$ to enough decimals, ties will be very unlikely.) Now we can define

$$\text{Count } R^2 = \frac{\text{number of correct predictions}}{\text{total number of observations}}$$

Although this is a useful measure worth reporting in all problems, it might not have enough discriminatory power. In this research, the author found that the logit model and the probit model accurately predicted all but three cases correctly. However, looking at $\hat{y}_i$ the linear probability model had more observations with $\hat{y}_i$ substantially greater than 1, thus outside the range of (0, 1).

This measure did not appear to assist the author much in discriminating between the three models as the other measures of $R^2$'s did. It is, however, possible that this measure has better discriminatory power in other problems. In any case, it is a measure worth reporting in every research problem.

In the discussion of the logit and probit models we discussed how a latent variable $y_i^*$ which was not observed, for which we could specify the regression model:

$$y_i^* = \beta x_i + u_i \qquad \text{Equation (7)}$$

For simplicity of exposition, assume there is only one explanatory variable. In the logit and probit models, what we observe is a dummy variable

$$y_i = \begin{cases} 1 & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases}$$

Suppose, however, that $y_i^*$ is observed if $y_i^* > 0$ and is not observed if $y_i^* < 0$. Then the observed $y_i$ will be defined as

$$y_i = \begin{cases} y_i^* = \beta x_i + u_i & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases} \qquad \text{Equation (8)}$$

$u_i \sim IN(0, \sigma^2)$

This is known as the *tobit model* (Tobin's probit) and was first analyzed in the econometrics literature by Tobin (1958). It is also known as *a censored normal regression model* because some observations on $y^*$ (those for which $y^* \leq 0$) are

censored (we are not allowed to see them). The objective is to estimate the parameters $\beta$ and $\sigma$.

Suppose that we wish to estimate the income elasticity of demand for enrollment. Let y* denote expenditures on higher education and (x) denote income, and we can state the regression equation as:

$$y_i^* = \beta x_i + u_i \qquad u_i \sim \text{in } (0,\sigma^2)$$

However, in the sample we would have a large number of observations for which the expenditures on enrollments is zero. Tobin argued that we should use the censored regression model. We can specify the model as

$$Y_i = \begin{cases} \beta x_i + u_i & \text{for those with positive education expenditures} \\ 0 & \text{for those with no education expenditures} \end{cases} \qquad \text{Equation (9)}$$

The structure of this model thus appears to be the same as that in equation (8).

There have been a very large number of applications of the tobit model (Amemiya, 1982). Take, for instance, hours (H) worked while attending school or wages (W). Since we have observations on a number of individuals, some of whom are employed while attending school and others not, we can specify the model for hours worked as

$$H_i = \begin{cases} \beta x_i + u_i & \text{for those working while attending school} \\ 0 & \text{for those who are not working} \end{cases} \qquad \text{Equation (10)}$$

Similarly, for wages we can specify the model

$$W_i = \begin{cases} \gamma z_i + v_i & \text{for those working} \\ 0 & \text{for those who are not working} \end{cases} \qquad \text{Equation (11)}$$

The structure of these models again appears to be the same as in equation (8). However, there are some limitations in the formulation of the models in equations 9 through 11.

Limitations of the Tobit Model

Consider the models of higher education expenditures in equation (9), of hours worked in equation (10), and of wages in equation (11). In each case there can be zero observations on some individuals in the sample and thus the structure of the model looks very similar to that in equation (8). But is it really? Every time we have some zero observations in the sample, it is tempting to use the tobit model. However, it is important to understand what the model in equation (8) really says. What we have in model equation (8) is a situation where $y_i^*$ can, *in principle*, take on negative values. However, we do not observe them because of censoring. Thus, the zero values are due to nonobservability. This is not the case with education expenditures, hours worked while attending school, or wages. These variables cannot, in principle, assume negative values. The observed zero values are due not to censoring, but due to the decisions of individual students. In this case the appropriate procedure would be to model

the decisions that produce the zero observations rather than use the tobit model mechanically.

Consider, for instance, the model of wages in equation (11). We can argue that each person has a reservation wage $W_1$ below which the person would not want to work. If $W_2$ is the market wage for this person (i.e., the wage that employers are willing to pay) and $W_2 \geq W_1$, then we will observe the person as working and the observed wage W is equal to $W_2$. On the other hand, if $W_1 < W_2$, we observe the person as not working and the observed wage is zero.

If this is the story behind the observed zero wages, we can formulate the model as follows. Let the reservation wages $W_{1i}$ and market wages $W_{2i}$ be given by

$$W_{1i} = \beta_1 x_{1i} + u_{1i}$$
$$W_{2i} = \beta_2 x_{2i} + u_{2i}$$

The observed $W_i$ is given by

$$W_i = \begin{cases} W_{2i} & \text{if } W_{2i} \geq W_{1i} \\ 0 & \text{otherwise} \end{cases}$$

We can write this as

$$W_1 = \begin{cases} \beta_2 x_{2i} + u_{2i} & \text{if } u_{2i} - u_{1i} \geq \beta_i x_{1i} - \beta_2 x_{2i} \\ 0 & \text{otherwise} \end{cases} \qquad \text{Equation (12)}$$

Note the difference between this formulation and the one in equation (8). The criterion that $W_1 = 0$ is not given by $u_{2i} \leq -\beta_2 x_{2i}$ as in the simple tobit model but by

$u_{2i} - u_{1i} < \beta_1 x_{1i} - \beta_2 x_{2i}$. Hence, estimation of a simple tobit model in this case produces inconsistent estimates of the parameters.

Estimation of the model given by equation (12) is somewhat complicated to be discussed here. However, the purpose of the example is to show that every time we have some zero observations, we should not use the tobit model. In fact, we can construct similar models for education expenditures and hours worked while attending school wherein the zero observations are a consequence of decisions by individuals. The simple censored regression model (or the tobit model) is applicable only in those cases where the latent variable can, in principle, take on negative values and the observed zero values are a consequence of censoring and nonobservability. Hence, the Tobit model was not utilized in this research.

# DISCUSSION AND CONCLUSIONS

## Summary of Study

Recent pricing policies in the state of North Carolina have resulted in increases in the direct cost of public higher education for prospective students and their parents. Although the full impact of these policies were not totally evident in the earlier part of the 1990's, examination of the responsiveness to price (which was significant) before such policies were fully realized should provide a valuable baseline of data to compare against that observed after cost increases have been put into effect. These increases, coupled with potential decreases in the traditional pool of applicants, have raised concern among many higher education officials with regard to the demand for enrollments among North Carolina's public four-year institutions. The purpose of this study was to examine the price elasticity of enrollments for these institutions, controlling for other economic, noneconomic, and environmental factors. Moreover, differential effects with regard to price and other determinants were to be observed across individual institutions and institutional types. Consequently, information was provided not only about price elasticity across institutions, but also about the demand dependency of different institutions on various subgroups of students.

This research was based on the investment approach to human capital theory. Using this approach, five sets of determinants were derived from the more general economic, noneconomic, environmental categories as identified by educational economists. The five sets of determinants were comprised of both student and external related factors, including: (1) eligible population; (2) educational background; (3) family income; (4) cost of attendance; and (5) county characteristics. Multiple regression was used to examine the specific variables comprising each set across three stages of analysis: (1) for fifteen public, four-year institutions in the state; (2) for three major types of public institutions; and (3) for each individual institution.

The results presented in chapter four are discussed in further detail in this chapter. The discussion is divided into three sections: (1) determinants of enrollments; (2) critique of research; and (3) conclusions. The first section is organized according to the five sets of determinants included in the three stages of analysis. The second section is a critique of the research based on the evaluation criteria identified and used in chapters two and three. These criteria referenced five specification issues as identified through review of past literature on enrollment demand: (1) correlates of demand; (2) measurement of financial aid; (3) stratification of data; (4) identification of demand function; and (5) level of choice.

## Determinants of Enrollment

### Eligible Population

The dependent variable was based on the demand dependency of the various institutions for which it was measured; thus, effects for the eligible population factor were measured directly in the general model for all stages of analysis. Because demand is dependent on the size of its relevant population, this factor is a necessary variable in analyses concerned with the demand dependency of different institutions. The results for this factor demonstrated that the size of the eligible population, or the number of high school graduates (HSSG) was a positive and statistically significant determinant of enrollments across all institutional types and across most institutions individually.

Only two of fifteen institutions appeared to be unresponsive to this factor--North Carolina Central University (NCCU) and University of North Carolina at Pembroke (UNC-P). NCCU was the only commuter institution in this sample; thus, the number of localities supporting freshmen class enrollments is restricted. Moreover, NCCU is located in the vicinity of several other public four-year institutions including Duke University, UNC-Chapel Hill, and North Carolina State University. The concentration of institutions in this area of the state necessarily restricts the proportion of freshmen enrollments NCCU would expect to attract across localities in this region. Consequently, a cross-sectional analysis of this

factor for NCCU was unlikely to reflect the dependency of this institution on the size of its eligible population pool.

It is likely that the location of UNC-Pembroke also was responsible for its low responsiveness to this factor. UNC-Pembroke (UNC-P) is located in a rural, less populous area of the state and the result of HSSG for this institution suggests that UNC-Pembroke depends on this area, or similar localities, for its freshmen student base. Such an interpretation for UNC-Pembroke was supported in results for the county characteristics factor. For both NCCU and UNC-Pembroke, HSSG had a lower correlation (about 0.2) with the dependent variable than did any of the other institutions.

Although direct comparisons cannot be made between stages one and two models and stage three models, results for some of the individual institutional models provided insight to differential effects for the grouped models. Among the grouped institutions, the urban universities (Group III) showed the least response to larger population pools. This was surprising in that these institutions are located in highly populous, urban areas where college enrollments presumably would be higher. However, looking at the results for UNC-Charlotte alone, it was found that after NCCU and UNC-Pembroke, it had the next lowest response to the HSSG factor. Also, UNC-Charlotte had a fairly low correlation between HSSG and the dependent variable. UNC-Charlotte is located close to the southern-most border of North Carolina where several

instate/out-of-state private institutions and out-of-state public campuses are accessible. This geographical fact may restrict UNC-Charlotte's enrollment proportions originating from the populous southern North Carolina localities, reducing the variance in enrollment proportions evidenced across the state. Inclusion of UNC-Charlotte in the urban institution group, therefore, may have reduced the effect of HSSG for this group as a whole.

Educational Background Factors

For all stages of analysis, mixed effects with regard to educational background factors were produced. Whereas high ability levels for high school graduates were hypothesized to have a positive effect on enrollment ratios, coefficients for the NCCT variable were primarily negative. In other words, enrollments were lower given higher ability levels across localities. The possible substitution of private, prestigious institutions or out-of-state public/private institutions among higher ability/income students may be an explanation for these outcomes.

Such an explanation should not be interpreted necessarily as a slight on North Carolina institutions. Similar results are likely to be found in other states. North Carolina institutions will, of course, be attractive to higher ability students from other states. Yet, it should be remembered that public support of higher education is generally directed not at the high ability, resident high school

graduates, who have more options, but at the lower ability graduates who, without locally provided options, might not continue their education. Tierney's (1980) research indicated this tendency, finding that private enrollment was substituted for public enrollment as the selectivity of private institutions increased relative to that for public institutions. Obviously, the more academically able the students, the greater their likelihood to evidence this substitution behavior.

Another possible explanation for the negative weight comes from the fact that NCCT was positively correlated with other factors such as HSSG and EDUL, but had a lower correlation with the criterion. In other words, NCCT may well have been acting as a suppresser variable (McNemar, 1962). Also, the correlation of NCCT with the dependent variable may necessarily be lower due to the distance in time between the administration of the test and the decision to enroll in postsecondary education. This resultant reduction in correlation would suggest measurement error with regard to NCCT, further inhibiting estimation of the effect of ability on enrollment.

For the one institution--UNC-Greensboro, having a statistically significant, positive coefficient for NCCT, the positive correlation between NCCT and the dependent variable is both significant and higher than that between EDUL and the dependent variable. In this regard, EDUL may have served as a suppresser variable for this model. Two other exceptions concerning negative outcomes involved the two traditionally black state universities, Elizabeth City State

University and Winston-Salem State University. Both institutions showed a considerably higher and statistically significant, negative correlation between NCCT and the dependent variable, while the correlation between EDUL and the dependent variable was positive. The negative coefficients in these instances may have been representative of the true effect.

Results for the educational attainment level of localities were consistent with expectations, given the above explanation for the one negative, nonsignificant coefficient for UNC-Greensboro. The higher educational environment was assumed to be a positive influence on students' preference for college enrollment. This effect proved to be particularly strong among institutions comprising the major universities (Group I) and the urban institutions (Group III). The statistical significance of this variable compared to the lack of significance for PRICE among the major universities suggests that noneconomic as opposed to economic factors may have been the more important determinants of enrollment in these institutions.

Family Income Factors

Several problems were encountered in attempt to estimate the effects of family income on enrollment. Measures reflecting the distribution of income within localities proved to be highly collinear with each other and with other variables in the models. Similar results were obtained when preliminary models

including selected interaction terms based on income and cost factors were examined. Finally, it was decided to include only a measure of median family income (log INCOME) in the models.

Results for INCOME, however, were uniformly weak and statistically nonsignificant. As suggested in chapter four, it is possible that the effects of INCOME on enrollment were accounted for by other variables in the models. For instance, the economic aspects of income are in some respects built into the price factor. Given that PRICE was a significant factor, it stands to reason that income, or the ability to finance a college education, was a factor in demand. Moreover, educational attainment has been used in the past to reflect family income levels as well as the tastes or preferences of consumers for higher education or human capital investment. The strong relationship in this research between EDUL and INCOME perhaps partially accounts for the weak effect of the income factor as incorporated in this study. In fact, in the institutional models, where education attainment was allowed to serve jointly as a noneconomic or preference measure and as a proxy for income levels, the effect for EDUL generally was found to be positive and statistically significant. The development of a more complete model using variable transformations, interaction terms, or proxy variables is recommended. For example, one might identify localities as having high, medium, or low income and also being high, medium, or low with regard to the educational attainment of their citizens. These

nine cells could then be represented by dummy variables and regression analysis could be utilized to investigate the significance of various interaction terms and/or direct effects as incorporated into different model specifications.

Cost Factors

In general, the direct cost measures, PRICE and BUDCON, had the expected results across institutional groupings and individual institutions. However, for the three major universities (individually and as a group), PRICE was not statistically significant at the 0.05 level of significance. Similar results have been evidenced primarily among studies on private enrollment demand (Hight, 1975; Hopkins, 1974; Spies, 1973; and Tierney, 1980). It could be argued that institutions in the major university group are similar in many respects to private institutions. Although the institutions included in the major university group are distinguished by their image as traditional comprehensive universities, their individual functions or missions are unique. Each institution is highly selective, due in part, to the limitation on its size by a legislative cap on enrollment. Moreover, as Hight (1975) and Hopkins (1974) suggest, to the extent that these schools have successfully differentiated their curricula, the possibility of substitution is lessened accordingly. Hence, the major university group may be more heterogeneous than expected.

The fact that PRICE elasticities were larger and significant for the Group II and Group III may also reflect substitution effects. The PRICE variable included tuition and fees, and living expenses where residency as opposed to commuter status was deemed appropriate. Because of this structure, PRICE became somewhat of a surrogate for distance from the institution. Living expenses for the Group II institutions were generally as high, if not higher, than those for the major universities, making PRICE for noncommuters at Group II schools comparable to that at the other types of institutions. In this regard, given the opportunity, students may have chosen to commute to local or nearby institutions or to attend more distant universities which offer a wider breadth of field at a relatively comparable cost. The greater PRICE elasticity for urban institutions (Group III), relative to that for the major universities (Group I), may reflect the dependency of urban institutions on more local populations for their freshmen enrollments. According to Leftwich (1964), the greater the availability of good or desirable substitutes, the greater the responsiveness to price changes. To the extent the major universities, other local, public colleges, or other enrollment options offer similar or greater benefits to students and the cost of these alternatives is about the same or less than that for urban institutions, then to that extent many students choose to substitute enrollment in these alternative institutions (or nonenrollment) for enrollment in urban institutions.

Results for the indirect cost measures were mixed. The confluence of effects for these two factors most likely contributed to the resultant outcomes. In other words, the higher the area wages, the greater the income foregone by college attendance. On the other hand, higher area wage rates may have meant that there was a greater ability to pay the direct costs of college attendance. The effect estimated for WAGES, therefore, was the net effect of two opposing influences on college attendance. As with the WAGES variable, the effect for URATE was probably two-fold and in opposite directions. A higher unemployment rate may have increased college attendance in that potential enrollees had greater difficulty finding employment in the local area. On the other hand, higher unemployment rates may have diminished the ability of households to support the education of recent graduates, thereby having a negative effect upon college attendance.

As noted in chapter four, signs for the WAGES and URATE coefficients did tend to have a pattern--negative for WAGES and positive for URATE. This pattern suggests that higher foregone earnings increased the perceived costs of enrollment, thus reducing the tendency to enroll, while higher unemployment rates reduced employment opportunities, encouraging students to invest their time, at least, in higher education. Nevertheless, the two-fold effects discussed earlier, not to mention the influence of other factors such as type of institution, appear to have inhibited adequate estimation of the effects of indirect costs as

measured here. More detailed analysis is required before further interpretation can be attempted.

County Characteristics

The generally negative and statistically significant coefficients for the county characteristics factor lends support to the suggestion of Becker (1975) and Feldman and Hoenack (1969) that rural backgrounds tend to influence enrollments negatively. The magnitude of coefficients for the institutional groupings were somewhat surprising in that one might have expected the urban institutions to respond most negatively to the rural localities. However, observing the individual models, it is noted that UNC-Charlotte had a positive, yet nonsignificant, response to this factor. This outcome could be responsible for the apparent underestimation of the AGIND effect for the urban institutions.

The one positive statistically significant coefficient for UNC-Pembroke, as explained in chapter four, correctly depicted both the rural location of the institution as well as its dependence on local, less populous, rural localities. Results for the AGIND factor, along with that for the HSSG factor, supported this interpretation for UNC-Pembroke.

## Critique of This Study

Most aspects of student and external related factors were included in the general model specifications for this research. Perhaps the greatest weakness regarding development of demand measures concerned the family income factor. The aggregate measure of median family income was found to correlate highly with several variables in the model. As in the Corazzini et al. research, access to individual data for this factor, allowing stratification of the sample by income groups, might have circumvented this problem. Such data, however, were not available. On the other hand, use of the educational attainment variable in the institutional models to express jointly noneconomic and economic factors proved to be an adequate means of indirectly observing income effects. Although it was impossible to estimate the separate effects of educational attainment and income, some insight as to the potential distributional effects of these factors across institutions and institutional types was obtained.

Due to the lack of data by locality in North Carolina, a cost factor reflecting financial aid awards was not included in the models. Nevertheless, any systematic variation in the type or amount of aid awarded across localities or institutions would result in biased PRICE coefficients as measured in this study. Omission of this factor also limited the ability of this study to indicate the effects of different pricing policies incorporating various mixes of financial aid awards.

Stratification was achieved through three stages of analysis: (1) statewide; (2) institutional grouping; and (3) individual institutions. Use of the same functional form for models developed in the statewide and institutional grouping analyses allowed observation of differential effects for individual factors across institutional groupings. While a different functional form for the institutional models (i.e., BUDCON was used rather than PRICE and INCOME) did not allow direct comparisons across all stages of analysis, differential effects observed across institutions provided insight to the effects observed for institutional groupings. Due to the lack of data on sex and race for high school graduates by locality, these factors were omitted in this study. While sex has not proved to be a highly significant factor in previous research, the presence of two predominantly black universities in the state of North Carolina makes exclusion of race measures particularly undesirable. The possible benefit of stratifying by income has already been noted; given the unexpected, mixed results for the ability measure (NCCT), stratification by income and ability is advised for future research.

The identification problem was circumvented in two ways. First, using a cross-sectional design, the supply of enrollment places was assumed constant and the price variable predetermined. In this regard, regression coefficients reflected only parameters of demand. Second, the development of a dependent variable such that it accounted for all instate freshmen enrollees allowed the

assumption of a fixed supply of potential enrollments with regard to nonprice rationing policies. A similar approach was used successfully for the same purpose in Hoenack's (1968) research.

This research used data aggregated at the county/city level across the state of North Carolina. Like most studies in the past, a corporate level decision on the part of a hypothetical "average student" was assumed. The decision whether or not to enroll in a North Carolina public, four-year institution was the type of decision being examined. Various factors reflecting the economic, noneconomic, and environmental aspects of students, the localities where they lived, and the institutions were incorporated in the models. While the available mix of institutions with regard to public, four-year institutions was covered in the model, the influence of private colleges, community colleges, and out-of-state institutions was not accounted for in the model specifications. The potential for such influences was noted in the discussion of results for ability (NCCT), cost (PRICE), and eligible population (HSSG). Moreover, to the extent the institutional groupings were not adequate summaries of the major types of institutions present in this state, these groupings introduce bias to the resultant coefficients in the models. However, the results for the individual models indicate that the institutional groupings were adequate for the types or subgroups of institutions examined in stage two models.

## Conclusion

The primary purpose of this research was to determine whether or not enrollments were price elastic among North Carolina's four-year institutions. According to the results reported in this study, enrollments generally were price elastic for the time period considered. More importantly, price elasticities were found to differ across institutions and institutional types, all other factors being equal. Differences in the effects of price, as well as in the effects of other factors, reflected the potential for substitution among various individual institutions, or institutional types, or between enrollment and nonenrollment altogether. Such information is particularly useful, given the additional knowledge about other factors that appeared to impede or encourage enrollments. Government officials and policy makers who ignore the price elasticity of North Carolina enrollments in the development of pricing policies might discover college access to be limited to smaller proportions of the state's high school graduates and the viability of the state's institutions to be threatened due to unexpected changes in the level and composition of enrollments.

Other factors found to have an overall significant effect on enrollments were eligible population, educational attainment of students' locality, and county characteristics. In general, the eligible population and educational attainment factors had positive effects on enrollments, while the rural character of a locality

had a negative effect on enrollments. Differential effects for these factors with regard to sign and magnitude also were observed among institutions. The mixed or weak effects for other variables were due primarily to the high correlation between these and other variables. The lack of individual as opposed to aggregate data on student related factors made it impossible to test a number of alternate measures and alternate model specifications in attempt to estimate the effects of these factors.

In the current research, logarithmic transformations were utilized for several measures since they produce constant elasticities for the related factors. Some other models were given consideration in this research; namely, (1) the linear probability model; (2) the logit model; and (3) the probit model.

The linear probability model has the drawback that the predicted values can be outside the permissible interval (0, 1). In the analysis of models with dummy dependent variables, we assume the existence of a latent (unobserved) continuous variable which is specified as the usual regression model. However, the latent variable can be observed only as a dichotomous variable.

The difference between the logit and probit models is in the assumptions made about the error term. If the error term has a logistic distribution, we have the logit model. If the error term has a normal distribution, we have the probit model. In this research, from the practical viewpoint, there is not much to

choose between the two models in that the descriptive results proved to be very similar.

When the logit and probit models are computed, adjustments have to be made with respect to the coefficients in order to make them comparable. For comparing the linear probability, logit, and probit models, we can observe the number of cases correctly predicted. However, this is not always adequate. It is usually better to look at some other measures of $R^2$. These results are presented in table 18 of appendix D.

The general functional form of the models used in this research appeared to fit the data rather well when compared to results of past research. The models showed particular improvement when stratified by institutional type and by individual institution, supporting the assumption of equally desirable institutions for a given enrollment group. Stratification in this manner allowed the special character or mission of an institution, or group of institutions, to be considered through the observation of differential effects of factors across institutions.

Hypothesis one (1) was confirmed; namely, price, or the direct cost of attendance and the nature of students' environment had a primarily negative effect on enrollment. Hypothesis two (2) was confirmed; namely, educational attainment level and size of high school graduate population had positive effects on enrollment. The findings of this research should be useful to state

government officials in considering pricing policies for the various institutions, and to institutional leaders interested in understanding more about the demand dependency of their institutions.

As noted earlier, the purpose of this research was to develop a preliminary model of factors which influenced the enrollment of North Carolina's high school graduates in its public four-year institutions of higher education and to determine whether these enrollments were price elastic across institutions. The models developed in this research appear to have accomplished this purpose. In general, the investment approach to enrollment demand based on the theory of human capital appeared to provide useful information about the nature of enrollments in North Carolina. Those factors associated with the costs of enrollment, or a reduction in the perceived benefits of college attendance, were found to inhibit enrollments, while those factors associated with potential benefits from college enrollment were found to encourage enrollments. As expected, exceptions to this pattern were evidenced through stratification of the data by institutional types and by individual institutions.

It would appear that the important point to consider as pricing policies are developed is the overall profile of financial backgrounds for students enrolling in a given institution. If the majority of enrollments are typically drawn from localities demonstrating a trend of economic distress, then increases in tuition may curtail enrollments to the extent that such a policy, in the long run, reduces

rather than increases the financial gain desired by the institution of higher education.

In the 1970's, 1980's and early 1990's, increasing college attendance by women, foreign students and older individuals helped colleges to more than compensate for declines in traditional enrollment. Over the next fifteen years, probable increases in traditional 18-22 year old enrollment implies that colleges will not need such steep increases in non-traditional enrollment, but higher tuition prices and increasing price elasticity of demand for college services will probably reduce the increase from levels previously forecast, necessitating efforts to attract non traditional audiences. As the US population ages, more buying power will be controlled by older individuals, and higher education must make suitable adjustments.

In the coming new environment for higher education revenues, tuition pricing, cost control and marketing will assume an even greater importance than today in managing colleges and universities. In the coming environment, state governments will spend more than they have in the recent past on higher education, but they will very likely spend less per student than they do today. More for less will be the prevailing philosophy at public colleges and universities in the twenty-first century.

## AREA FOR FURTHER RESEARCH

An area for further research involves an examination of Distance Education as it relates to determinants and distributional aspects of enrollment in US higher education. Literature was reviewed in topical areas relevant to the application of the distance education concept. Generally, the focus was on the applicability of the issues to higher education. The literature indicates that the application of distance learning in higher education can be learning effective and cost effective.

A review of literature in the area of cognitive learning theory related to distance education found that, although no single or unified learning theory of distance education exists, four attributes of effective learning process theories are applicable to the distance education concept. These learning process theories are as follows: (1) active learning and knowledge construction; (2) cooperative learning; (3) problem-solving as an approach to learning; and (4) collaborative learning.

### Active Learning and Knowledge Construction

Cognitive models of learning stress that learning is an active, constructive, and goal-oriented process (Shuell, 1986). Learners construct meaning from the

material studied by processing it through existing mental structures and then retaining it in long-term memory where it remains available for further processing and possible reconstruction (Johnson, Johnson, & Smith, 1991). Within this context, learning is best accomplished by engaging students in constructing knowledge through acquiring, generating, analyzing, manipulating, and structuring information.

Cooperative Learning

Some learning theories emphasize learning's social genesis and suggest the view that it is a social process that occurs more effectively through interpersonal interactions in a cooperative (versus a competitive) context (Vygotsky, 1978). Research has found that the positive motivational and effective cognitive aspects are involved in group-oriented learning processes (Brown & Palincsar, 1989). Teamwork in learning extends the locus of meta-cognitive activity by providing triggers for cognitive dissatisfaction outside the individual. Team members can monitor individual thinking, opinions, and beliefs and provide feedback for clarification and change in the learning process. Additionally, a learner's exposure to alternative points of view can challenge her or his initial understanding and thus motivate learning (Glaser & Bassok, 1989). Cooperation and teamwork can further support learning by providing social support and encouragement for individual efforts.

## Problem Solving As An Approach to Learning

The concept of learning through problem solving is supported by the hypothesis that learning is a process of building and transforming mental models, wherein cognitive representation of elements comprising a domain and their interrelationship are created (Neches, 1987). Such transformations involve changes in organization and structure of knowledge and primarily occur in the context of problem solving. Learning in such a scenario is thought to be expedited in challenging problem-solving situations in which mental models are tested, extended, and refined until they are effective and reliable in solving that problem.

## Collaborative Learning

Collaborative learning involves interpersonal processes by which a small group of students work together to complete an academic problem-solving task designed to promote learning. In the collaborative learning approach, "collaborative activities lead to emergent knowledge, which is the result (not summation) of interaction of the understandings of those who contribute to its formation" (Whipple, 1987, p. 5). Collaborative activities enhance learning by allowing individuals to exercise, verify, solidify, and improve their mental models

through discussions and information sharing during the problem-solving process. Collaborative learning in higher education increases student involvement with the course material and with one another as they work together in small groups in performing an academic task. Technology facilitates the collaborative learning process in distance education scenarios. McKeackie, Pintrich, Lin, and Smith (1987) found that working in interacting groups facilitates students' acquisition of critical thinking skills and meta-cognitive learning strategies, such as self-monitoring and learning how to learn. Smith (1986) found that, in higher education settings, collaborative procedures (student-student interactions) are related to higher levels of critical and active thinking and lower levels of rote memorization.

Collaborative learning procedures have also been found to be more effective than traditional instructional methods in promoting student learning and academic achievement. Additionally, collaborative learning procedures have been found to enhance student satisfaction with the learning experience. These and other research findings have led to a growing interest in use of collaboration learning in higher education as a viable and effective instructional strategy in a distance education scenario (Cooper, Prescott, Cock, & Smith, 1990).

## Academic Discipline of Distance Education

Mayor (1996) stated that one "consequence of the rise of the audiovisual communications media is the passivity of human behavior in front of the screen. The citizen of the twenty-first century is a televiewer rather than a 'teleactor,' and is usually regarded as a consumer-of images, information, entertainment and knowledge. Only students who have learned to master interactive machines and processes since childhood and know how to extract from the electronic media exactly what they need for their own growth can resist the powerful fascination of multimedia. For those who are less familiar with the technology, the discovery of the medium takes precedence over the message. Another paradox of the new situation is that content is the poor relation in a revolution based on hardware, technology and processes" (p.39).

Mayor (1996) also noted that one "reason for drawing attention to the dangers associated with these changes is to improve our capacity to cope with them. We must welcome and exploit the possibilities opened up by the new information technology, especially in view of current trends in higher education: increasing diversification of the student population and student demand (in terms of age, expectations and training programs), financial difficulties in many cases due to cuts in government expenditure on higher education and the need to make training courses more flexible in order to follow market requirements. We

must keep pace with change and, if possible, keep ahead of it. In order to present a synthesis of the main trends in higher education and set forth guidelines for its future policies in this field, UNESCO recently published a policy paper entitled Change and Development in Higher Education. It is to be expected that the new information technologies will broaden access to higher education in all its diversity, and that the role of open universities and distance-education systems will continue to expand" (p. 39).

Lastly in this context, Mayor (1996) concluded that: "Steps must be taken to use the mobility, flexibility, leanness and speed of the new information technologies to bring about real sharing of knowledge. Actions speak louder than words: UNESCO did not wait until all the promise of these technologies was fulfilled before launching its 'Learning without Frontiers' program. Its Member States decided that in 1996-97 special attention would be paid to the use of technology in education. In higher education, the UNITWIN/UNESCO Chairs Program is continuing to promote solidarity and cooperation between universities" (p. 39).

## Organization and Structure of Distance Education

Aiken, Bartelt, Hoffman, Marino, and Schleyer (1995) reported on the establishment of a distance education structure at Temple University in

Philadelphia. Temple University is a typical urban institution of higher education. Temple is "a liberal arts college, a cluster of professional schools, a major employer in the city, a provider of health care to the city's poorest residents, and so on. Located in the heart of North Philadelphia, an economically disadvantaged community, Temple draws undergraduate students form the city, the region, and the Eastern seaboard. The majority of Temple students come from working-class families, and many are the first in their families to go to college. Temple is comprised of 14 schools and colleges including medical, dental, and law schools, allied health, education, and so forth, of which the College of Arts and Sciences, with 7,000 students, is largest. There are about 31,000 students (including 1,500 on our campus in Japan, of which roughly 19 percent are African American, 12 percent are Asian, and small numbers are Latino and members of other ethnic groups. Temple employs approximately 1,700 full-time faculty" (p. 49).

Chronically "under funded, ambitious, and stretched thin, Temple nonetheless has planned for and spent money on technology over the last decade for administrative, research, and teaching purposes. Although administrative and research computing have benefited from university-wide planning, there has been no such planning for the use of technology to improve teaching and learning. Thus, despite the dollars spent, faculty have experienced

Temple's policy as what Steve Gilbert has characterized as 'lurch, crisis, lurch, crisis.' The result is a system that is out of whack. For example, Temple has state-of-the-art technology in its Instructional Support Center, but faculty who make their own multimedia presentations must compete to use one of Temple's two high-intensity projectors. As on many campuses, 'pioneer' faculty are using a variety of teaching technologies, and Temple has some real leaders in various fields. Like all pioneers, they have been persistent and creative enough to contend with outdated and malfunctioning equipment and sporadic support from over-burdened technical people" (Aiken, Bartelt, Hoffman, Marino, & Schleyer, 1995, p. 50).

At Temple, "approximately 40 percent of the faculty have computers in their offices, 15 percent use e-mail, and 20 percent use voice mail. Many buildings are wired for network connections. Central systems that permit the use of technology university-wide include an Ethernet backbone, two auditoriums equipped to receive satellite broadcasts, four distance learning classrooms connecting main and branch campuses, and centralized computer facilities for academic and administrative computing. The largest facilities for student use are the Scholars' Information Center at our main library and the Student Computing Center with 200 stations, and there are many other smaller student computing centers" (Aiken, Bartelt, Woffman, Marino, & Schleyer, 1995, p. 50).

Temple also has a laptop "'loaner' service for students, with over 100 machines available at $1 per day. Some classrooms are equipped with computers, but because of demand, few are available for an entire course. The most recent uses of technology for teaching campus-wide are e-mail (accounts are available to all students); electronic conferencing to create 'virtual' communities and paperless classrooms; commercial software (computer-assisted instruction, CD-ROM, and hypertext); and video and other 'TV-like' media" (Aiken, Bartelet, Hoffman, Marino, & Schleyer, 1995, p. 50).

Temple established a technology and distance education committee called a "Roundtable." "The Roundtable has defined several purposes: (1) to be an advocacy group for the effective use of technology for teaching; (2) to assess and recommend extensions of our current practices; (3) to enable 'mainstream' faculty to use technology in teaching; and (4) to explore the use of technology to reach new or hard-to-reach student populations. With new resources for technology nearly impossible to come by, the ... Roundtable recognizes that in order to effectively advocate the real location of current resources, it must be activist, visible, and vocal in supporting teaching with technology. The Roundtable took on one further task: to coordinate with other major university planning efforts, especially the University Communications Planning Committee and the technology committees in each of Temple's schools and colleges. The

Communications Planning Committee has just completed a comprehensive plan and recommendations for hardware up-grades and extensions as well as an integrated mail system for all faculty, students, and staff (text, graphics, video, and voice), integration of library resources across Temple's campuses, CD-ROM access for more people simultaneously, dial-in access for New Jersey, and Scholars' Information Centers for all campuses. The technology committees differ from college to college, but most have written computing plans. They also collect and prioritize requests for hardware, and some have solicited proposals from faculty to buy equipment and software for specific courses. With the exception of the College of Health, Physical Education, Recreation, and Dance, where all faculty are now using some form of technology in teaching, the committees have not focused on integrating technology systematically into teaching or evaluating teaching" (Aiken, Bartelt, Hoffman, Marino, & Schleyer, 1995, p. 50).

The Roundtable's overall goal is to bring technology and teaching together, and thereby to enhance learning. Temple's Roundtree is working through three subcommittees informally called, Changing the Culture, Teaching and Learning, and Distance Learning. "These are start-up subcommittees and probably will be replaced with new subcommittees in a few months. The first two respond to our need for a 'read' of Temple's organizational culture and an

accurate account of its current teaching, learning, and technology 'best practices' on campus before in-depth planning can begin. The third responds to necessity: we need better links with our multiple campuses, and we want to explore the revenue-producing possibilities of reaching adult and distant students" (Aiken, Bartelt, Hoffman, Marino, & Schleyer, 1995, p. 51).

The Changing the Culture (CTC) subcommittee is focused on understanding Temple's organizational culture as it relates to information technology in order to broaden acceptance and diffusion. "A problem in defining the culture is that information technology is an 'enabling' technology in most disciplines, and not the focus of the discipline itself. Thus, the places one would ordinarily begin-university mission statements, descriptions of academic programs-rarely discuss information technology. This subcommittee then must capture the Temple technology culture indirectly from ideas and sentiments 'in the air.' The CTC subcommittee has focused on four questions: (1) How is information technology culture defined in organizations such as Temple University? (2) What is the current information technology culture at Temple? (3) What is the desired information technology culture at Temple? (4) How can the culture be changed?" (Aiken, Bartelt, Hoffman, Marino, & Schleyer, 1995, p. 52).

The Teaching and Learning (TL) subcommittee started its work with the "premise that once we better understand Temple's culture for adopting innovation, then our own pioneer faculty will be our best change agents. Its primary task is identifying across the university our current best practices, but already it is spreading germs of innovation indirectly as a consequence of its inquiries, and discovering-not surprisingly-that while faculty may know the practices of their disciplinary colleagues across the country and around the world, they haven't a clue that their colleagues in the department down the hall are teaching with technology. The TL subcommittee's goal is to catalogue technology practitioners and practices here at home, taking into account the crucial role of support services and facilities" (Aiken, Bartelt, Hoffman, Marino, & Schleyer, 1995, p. 52).

The Distance Learning (DL) subcommittee centers its discussions on alternative modes for delivering instruction-the possibilities that satellite, video, and interactive classroom technology open up to the university. In addition, it will explore links with publishers who are increasingly interested in 'custom publishing' (producing 'book-like' electronic course packs that go directly to faculty), and the set of thorny legal issues that arise when universities broadcast courses over state boundaries, for example. This committee also will assess the

results of learning via our distance learning classrooms, and will ask about the consequences for teachers and learners of hook-ups with the main campus for students in Harrisburg, on our campuses north of Philadelphia, or on our international campuses in Japan, Rome, and London" (Aiken, Bartelt, Hoffman, Marino, & Schleyer, 1995, p. 52).

## Advantages of Distance Education

Mayor (1996) observed that: "New information and communication technologies, especially the Internet, are offering researchers, educators, artists, and administrators all over the world an opportunity to form the most cultivated, specialized, versatile and active intellectual community that the world has ever known-a kind of global university. The emergence of these technologies has revolutionized our ways of thinking and living in recent years and opened up numerous prospects for creating worldwide links between universities, institutes of higher education and research, libraries, laboratories and hospitals, disseminating knowledge, promoting personalized teaching, education tailored to the needs of individuals and groups, the exchange of ideas and data and the implementation of collective projects. It soon became clear that among the many fields where the new technologies may be applied-especially the high-capacity networks known as information superhighways that can carry data, sound and

images-higher education, research and the promotion and dissemination of knowledge are those with the richest potential" (p. 38).

## Media in Distance Education

Media technology supports learning in distance education settings through one or a combination of the following four mechanisms, as follows: (1) process support; (2) process structure; (3) task structure; and (4) task support (Nunamaker Dennis, Valacich, Vogel, & George, 1991). Process support is provided through an electronic communication infrastructure. Process structure refers to techniques or rules that direct the pattern, timing, or content of learner interactions. Task support refers to the information and computational infrastructure (e.g., external databases and computational models) provided. Task structure refers to the analytical techniques and models for processing task-related information and task accomplishment. These four mechanisms are the primary means by which the application of media technology increases the effectiveness in the learning process in distance education scenarios. This outcome is accomplished by increasing group gains and reducing process losses. Process gains refer to the synergistic aspects of the learner interaction that improve group performance relative to the individual member performance. Process losses refer to aspects of the learner interactions that impair group

performance relative to the efforts of individual members working alone. Following are examples of process gains and process losses (Nunamaker Dennis, Valacich, Vogel, & George, 1991):

1. Process gains:
    a. A group of learners as a whole generates more information and alternatives compared to the average group member as an individual learner.
    b. Learner groups are more effective and objective in evaluation and error detection tasks compared to the average group member as an individual learner.
    c. Working in a learner group may motivate the individual member to perform better than would be the case if they were performing individually.
    d. Interactions among the learner group members lead to synergies.
2. Process losses:
    a. Learner participation in the group process is fragmented (i.e., learner group members should take turns in communicating).
    b. One or a few individual members may dominate learner group discussions and monopolize the learner group's time.

c. Fear of negative evaluation (evaluation apprehension) causes some learner group members to withdraw and avoid participating in the group discussions.

d. Higher volumes of information generated during the learner group process creates a condition of information overload for some individual learners.

Laboratory and field studies have shown that media technology capabilities and features can facilitate learner group interactions and improve group performance by increasing process gains and reducing process losses (Pinsonneault & Kraemer, 1990). Electronic communication channels increase the amount of information and alternatives generated by learner groups (a process gain) by providing simultaneous input channels and thus, eliminating or reducing fragmentation of member participation (a process loss). Anonymity of electronic input can decrease or eliminate evaluation apprehension (a process loss) leading to an increase in learner participation and the amount of information generated by the learner group (a process gain).

## The Economic Factor of Instructional Technology In Distance Education

Definitions of instructional technology typically vary according to the way in which the factor is conceptualized by those individuals constructing the

definitions (Saettler, 1994). There are two widely accepted conceptualizations of instructional technology-the physical science concept and the behavioral science concept.

When instructional technology is considered within the context of physical science, it is typically viewed as the application of physical science and engineering technology to the process of education (Saettler, 1994). This concept emphasizes device effects and procedures, as opposed to instructional content and learner differences. The development of the physical science concept of instructional technology was not greatly influenced by the interrelationships between educational needs and psychological theory, on the one hand, and the design of instructional messages and media, on the other hand.

The most significant theoretical premise embodied in the physical science concept of instructional technology is that which casts materials and machines in nonverbal roles and traditional media (lectures, books) in verbal roles (Brown, Lewis, & Harcleroad, 1995). The implicit assumption contained in this concept is that nonverbal media are more effective. Regardless of its validity or its ability to stand alone, the physical science concept of instructional technology gained a wide acceptance through the first three quarters of the twentieth century (Saettler, 1994).

The behavioral sciences are anthropology, sociology, and psychology. When instructional technology is conceptualized in the context of the behavioral sciences, its development and application is considered in terms of learning psychology, group processes, language and linguistics, communications, cybernetics, perception, and psychometrics (Saettler, 1994).

The behavioral science concept of instructional technology, however, also incorporates applications of engineering research (particularly human factors engineering), logistics related to the effective use of physical resources, and contemporary technology, such as computers (Saettler, 1994). Thus, the behavioral science concept of instructional technology does not reject the physical science concept. Rather, it incorporates the physical science concept in a broader perspective.

A useful definition of instructional technology for the first-half of the decade of the 1990s requires elements of both the physical science and the behavioral science concepts. While the effective use of instructional technology requires the consideration of the tenets of learning psychology, group processes, language and linguistics, communications, cybernetics, perception, and psychometrics, the contemporary applications of instructional psychology are heavily dependent upon physical science-based technology.

A traditional assumption in education is that a fairly smooth and rapid path exists through which research flows from the developmental phase to the application of results (Carter, 1994). Unfortunately, this path is often neither smooth nor rapid. Resistance to the application of new technology to the education process comes from administrators, instructors, and students. Further, research results are often insufficiently formulated for ease of application in teaching environments.

The application of technology to the educational process requires expert preparation and adaptation of the technology for use in learning environments. Further, an educational process is required as a means of persuading administrators, instructors, and students of the value of the technology in the leaming process. An illustration of this problem may be gained through a consideration of computer-aided instruction (CAI). CAI began to gain a wide acceptance in the mid-1980s (*ERIC 317 836, 1990*). Prior to that time, however, inadequate instructional materials provided for use in CAI caused many instructors and students alike to become disenchanted with the technology. It is significant to note that the technology was not at fault. The fault lay in the adaptation of the technology to the learning environment (Carter, 1994).

Another problem encountered in the application of technology concerns rapidly developing and changing technology (Howe, 1994). This problem is

particularly acute with a technology much as computer science, in which new developments occur faster that the existing technology can readily be absorbed into the educational process. In the 1990s, the use of computers in the learning environment is the premier manifestation of the application of technology to the educational process.

There are many ways in which computer science may contribute to the enhancement of the educational process. At the student level, such enhancement cannot occur, until the students are capable of interacting with computers (Dahl & Grafenauer, 1994). Obviously, then, the development of computer literacy is the starting point for the introduction of computer into the learning environment.

In the most basic of applications, CAI is used to present drills, practice exercises, tutorial sequences, and to engage students in dialogues related to the substance of the instruction. CAI has proven to be successful where the instructional goals are well defined, achievement of the goals is highly valued by the institution and the substance of the instruction is suited to computerized delivery. The advantages of CAI are held to be a shorter learning time and improved levels of performance.

There are a number of reasons why CAI can be effective in instruction. One of these advantages is the novelty of the teaching approach. It is possible

for CAI to transform dull tasks into interesting or even exciting activities. Novelty, however, is a two edged sword. Novelty soon wears thin. Its advantage, therefore, is in the generation of initial interest. When novelty wanes, the CAI instructional program must be capable of maintaining student interest.

One way in which CAI can maintain interest on the part of students is through the characteristic of dynamic text (Higgins & Boone, 1990). The text presented in a CAI software program, however, is capable of being manipulated by either teacher or student. Thus, text changes may be effected to accommodate either the interests or the needs of student users. Similarly, the presentation format can be adapted to provide variety, or to accommodate special instructional needs.

Technological innovations in hypermedia have increased the possibilities for learners to become more successful (Duckworth & Taylor, 1995). The application of hypertext technology to the teaching of reading, as an example, appears to offer substantial advantages over traditional text-based instruction for at-risk learners.

CAI software programs are also capable of providing on-line tools. Thus, the programs may make instantly available to student users a wide variety of professional tools and information bases.

Another significant characteristic of CAI software programs is their capability to reflect the cognitive processes of the topic being taught (Anderson-Inman, 1994). CAI software programs may be designed to take advantage of the knowledge and experience levels of specific student users. The ability of CAI software to relate the learning experience to the learner's prior experiences and knowledge is of inestimable value in the teaching of mathematics.

Several specific advantages are provided by CAI software programs in the teaching of mathematics. The most significant of the advantages available through the use of CAI are as follows:

1. CAI software programs permit the placing of emphasis on a comprehensive understanding of a topic, as opposed to specific aspects of a topic.
2. CAI software programs actively involve student users in the learning process. Students learn through interaction with their environments. The computer becomes a part of student environments. The experience of students with CAI software programs becomes a part of their backgrounds, from which they will recall as required in future learning situations. Students learn to reflect on their own ideas and experiences, and to relate them to potential future outcomes.

## Economics of Mass Distance Education

Mayor (1996) noted that: "Cyberspace has no frontiers, limits or rules. Theoretically it belongs to everyone. A supremely efficient vector of communication and a place where freedom of thought may be exercised, it welcomes all who use it. But it is only accessible to those who have the requisite electricity, computer, telephone hookups and know-how. This paradox recalls the ambivalence of the work 'sharing,' which denotes both conjunction, as in the breaking and distribution of bread, and division, as in 'time-sharing.' A whole must be divided before the parts can be distributed" (p. 38). The economics of distance education suggests there are economies of scale and thus could be a cost effective alternative to deliver higher education courses. However, there are many disadvantages, and efficient planning is essential to ensure success.

Descriptive information is given in appendix G that demonstrates the impact of Distance Education and Instructional Technology on the changing markets of labor and higher education. The information in appendix G will be of valuable use in planned research for the future.

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## Appendix A

## DATA SOURCES AND METHODS OF MEASUREMENT

Counties (n=100) and cities (n=36) were used as the units of analysis with data coming primarily from previously published state reports and census data. A description of each variable, how it was measured, and its data source are given below:

Dependent Variable

E – the ratio of the number of students from a county/city enrolled as first-time entering freshmen at a particular institution to the total instate first-time entering freshman enrollment for that same institution. Data for both the numerator (number of first-time freshmen enrolled in a given institution by county/city) and the denominator (total first-time freshmen enrollment) were obtained from completion of reports for each four-year institution in North Carolina and was made available for this study through the UNC Board of Governors for Colleges and Universities.

Independent Variables

HSSG – the total number of high school graduates by county/city. The source of data for this variable was Statistical Data on Public Schools, published by the Division of Management Information Services of the North Carolina Department of Public Instruction, January 1996.

PRICE – the cost of college attendance including tuition, required fees, and living expenses. These charges were included in the price factor only when a county/city was determined to be outside a reasonable commuting range for a particular institution. The commuting range was thirty (30) miles for institutions where a policy exists requiring all freshmen to live on campus. Otherwise, the commuting range was fifty (50) miles. Data on tuition and required fees were obtained from state reports on instate undergraduate tuition.

WAGE – the average weekly wage (measured in thousands) of production workers by county/city. The source of data for this variable was the average weekly manufacturing wage as published in a report on quarterly gross wages and average weekly wages by county/city.

This report is prepared annually by the North Carolina Employment Security Commission.

URATE – the unemployment rate as measured by the proportion of the total civilian labor force that was unemployed by county/city. The source of data was the "Population and Labor Force Data" report published by the Manpower Research Division of the North Carolina Employment Security Commission, August 1995.

AGIND – county/city characteristics expressed through the level of economic activity within three major industrial groups: (1) AGIND – natural resource industries such as agriculture and mining; (2) other non-natural resource industries such as construction and manufacturing; and (3) SVCIND – support industries such as transportation, trade, finance, and service. Economic activity was measured as the percentage of income generated by each of these industry groups. These data were obtained from a report on quarterly gross wages and average weekly wages per worker by county/city prepared annually by the North Carolina Employment Security Commission.

NCCT – average ability score (NCCT or North Carolina Competency Test) for students in the 1995 graduating class of all high schools by county/city. Statistical Data on North Carolina Public Schools, published by the Division of Management Information services of the Department of Public Instruction, January 1996.

EDUL – the proportion of adults (age 25 or older) by county/city who had completed one or more years of college. Data on educational attainment were drawn form the North Carolina section of the 1990 census report, Characteristics of the Population: General Social and Economic Indicators, U.S. Department of Commerce, Bureau of the Census.

INCOME – the median household income by county/city. Data for this variable were obtained form the "1996 Survey of Buying Power", Sales and Marketing Management, July 1996.

Appendix B

NORTH CAROLINA COUNTIES

ALPHABETICAL LISTING

Alamance County
Alexander County
Alleghany County
Anson County
Ashe County
Avery County
Beaufort County
Bertie County
Bladen County
Brunswick County
Buncombe County
Burke County
Cabarrus County
Caldwell County
Camden County
Carteret County
Caswell County
Catawba County
Chatham County
Cherokee County
Chowan County
Clay County
Cleveland County
Columbus County
Craven County
Cumberland County
Currituck County
Dare County
Davidson County
Davie County
Duplin County
Durham County
Edgecombe County
Forsyth County
Franklin County
Gaston county
Gates County
Graham County
Granville County
Greene County
Guilford County
Halifax County
Harnett County
Haywood County
Henderson County
Hertford County
Hoke County
Hyde County
Iredell County
Jackson County
Johnston County
Jones County
Lee County
Lenoir County
Lincoln County
Macon County
Madison County
Martin County
McDowell County
Mecklenburg County
Mitchell County
Montgomery County
Moore County
Nash County
New Hanover County
Northampton County
Onslow County
Orange County
Pasquotank County
Pamlico County
Pender County
Perquimans County
Person County
Pitt County
Polk County
Richmond County
Randolph County
Robeson County
Rockingham County
Rowan County
Rutherford County
Sampson County
Scotland County
Stanly County
Stokes County
Surry County
Swain County
Transylvania County
Tyrrell County
Union County
Vance County
Wake County
Warren County
Washington County
Watauga County
Wayne County
Wilkes County
Wilson County
Yadkin County
Yancey County

## Appendix C

## NORTH CAROLINA'S PUBLIC FOUR YEAR INSTITUTIONS BY GROUPING

Group I

1. University of North Carolina - Chapel Hill
2. NC State University
3. East Carolina University
4. Appalachian University
5. UNC - Asheville

Group II

1. UNC - Wilmington
2. UNC - Greensboro
3. UNC - Charlotte
4. Fayetteville State University
5. Western Carolina University

Group III

1. North Carolina Central University
2. UNC - Pembroke
3. NC School of the Arts
4. Elizabeth City State University
5. Winston Salem State University

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## TABLE 1

## SUMMARY OF REVIEWED STUDIES

| STUDENT FACTORS | BISHOP | CORAZZINI | HOENACK | MUNDEL | TIERNEY |
|---|---|---|---|---|---|
| Economic:<br><br>Family Income<br><br>Family Socio-Economic Status (SES) | Family Income<br>Used as stratification variable; differential effects revealed<br><br>Family SES<br>SES of family neighborhood reflect income, family tastes & preferences, as well as local characteristics generally a positive effect | Family SES<br>Used as stratification variable; differential effects revealed | Family Income<br>Used as stratification variable; differential effects revealed | Family Income<br>Used as stratification variable; differential effects revealed | Family Income<br>Used with race as stratification variable; differential effects revealed |
| Noneconomic:<br><br>Academic Ability<br><br>Academic Aspirations<br><br>Sex<br><br>Race<br><br>Program Preference | Academic Ability<br>Used as stratification variable; significant differential effects revealed<br><br>Sex<br>Sample based on male students only<br><br>Race<br>Used only to specify feasible college alternatives | Academic Ability<br>Positive effects; proxy for tastes for higher education & for ability to overcome admissions restrictions<br><br>Sex<br>Mix effects; few significant results revealed | Academic Ability<br>Controlled through dependent variable ratio | Academic Ability<br>Evaluated in terms of difference between student ability and IHE average ability; students prefer not to attend IHE where average ability is too far above their own<br><br>Sex<br>No significant effects | Academic Ability<br>Mixed effects with regard to sign, no significant coefficients<br><br>Academic Aspirations<br>Few significant effects except for upper income students aspiring to more than bachelor's degree, which increases likelihood of enrollment in private IHE |
| Environmental:<br><br>Parental Education | ——— | Parental Education<br>Positive effect for father's education; also a proxy for ability to finance education | ——— | Parental Education<br>Paternal education generally has greater effect than maternal; general decrease in importance of parental education as income increases | Parental Education<br>Paternal and maternal education used; mixed effects with regard to sign, no significant coefficients |

TABLE 1 - Continued

| EXTERNAL FACTORS | BISHOP | CORAZZINI | HOENACK | MUNDEL | TIERNEY |
|---|---|---|---|---|---|
| Economic:<br><br>Tuition or Direct Cost<br><br>Financial Aid<br><br>Opportunity Cost or Indirect Cost<br><br>Unemployment Rate | Tuition<br>Negative effects for tuition, room and board, and travel costs; some positive yet nonsignificant effects attributed to indifference to enrollment at corresponding IHE<br><br>Opportunity Cost<br>Negative effects except among some income/ability groups where coefficients are not significant | Tuition<br>Negative effects; some positive yet nonsignificant effects may be due to indifference to enrollment at corresponding IHE<br><br>Opportunity Cost<br>Negative effects except among high SES group where coefficient was not significant<br><br>Unemployment Rate<br>Positive nonsignificant effects except among high SES group - possible confluence with opportunity cost | Tuition<br>Negative effect; substitution of lower priced institution indicated<br><br>Opportunity Cost<br>Negative effects; significant for all campuses<br><br>Unemployment Rate<br>Mixed effect due to confluence with opportunity cost | Tuition<br>Negative effects increasingly strong as incomes fall; room and board charges shift from negative to positive as income rises - indicates "quality of life" influence | Tuition<br>Negative effects significant for all but lower income nonwhite students<br><br>Financial Aid<br>Positive effects for all but one coefficient - that of work study for upper income nonwhite students. Lack of significance evidenced for low income nonwhite students |
| Noneconomic:<br><br>Type of Institution<br><br>Location of IHE<br><br>Admissions / Selectivity<br><br>Breadth of Field | Type of Institution<br>Examined with respect to location<br><br>Location<br>Examined with respect to type of institution; few significant results<br><br>Admissions<br>Negative effect. High standards constrain enrollments - depends on ability<br><br>Breadth of Field<br>Positive effect generally | Type of Institution<br>Indicated via cost factor for each type IHE in each model; differential effects revealed | Type of Institution<br>Models derived for each UC campus included costs for alternative IHE's. Indicates state colleges are good substitutes for UC campuses<br><br>Quality of IHE<br>Indicated via tuition or direct cost variable; cost has less effect among higher quality IHE | Location<br>Used to reflect probability of residency; positive effect revealed<br><br>Selectivity<br>Average ability used to reflect students attraction to selective IHE. Positive effect revealed to extent average IHE ability is not too far beyond that of student<br><br>Breadth of Field<br>Positive effect revealed; strongest effect among middle income group | Type of Institution<br>Limited to public versus private types<br><br>Location<br>No significant effects; signs imply nonwhites may be more mobile than whites<br><br>Selectivity<br>Significant for two-thirds of coefficients; as selectivity at private IHE increases relative to that of public IHE, students more likely to enroll in private IHE |
| Environmental:<br><br>Local/Regional Characteristics<br><br>Population Size<br><br>Draft | Local Characteristics<br>SES of family neighborhood used to reflect benefits of associating with "better class of people"; generally positive effects<br><br>Draft<br>Some significant positive effects | Population Size<br>Controlled through dependent variable ratio | Population Size<br>Controls for relevant population size; typically a positive effect | ——— | ——— |

## Table 2

## REGRESSION RESULTS BY INSTITUTIONAL GROUPING

| Institutional Grouping | $R^2$ | Constant | Log HSSG | NCCT | EDUL | Log INCOME | Log PRICE | WAGE | URATE | AGIND |
|---|---|---|---|---|---|---|---|---|---|---|
| Group I | 0.499 | -6.832 | 0.642** | -0.007 | 4.084** | -0.233 | -0.154 | -0.378 | 0.482 | -1.251** |
| Group II | 0.482 | 4.155 | 0.520** | -0.0002 | 1.634** | 0.066 | -1.802** | 0.312 | -0.666 | -1.012** |
| Group III | 0.556 | 1.842 | 0.493** | -0.023** | 3.983** | 0.212 | -1.723** | -0.981 | 1.118 | -0.866* |
| Statewide | 0.327 | -0.212 | 0.486** | -0.014** | 2.553** | 0.009 | -1.133** | -0.191 | 0.614 | -0.798** |

* Significant at p > 0.05
** Significant at p > 0.01

## Table 3

## REGRESSION RESULTS FOR INDIVIDUAL INSTITUTIONS

| Institution | $R^2$ | Constant | Log HSSG | NCCT | EDUL | Log BUDCON | WAGE | URATE | AGIND |
|---|---|---|---|---|---|---|---|---|---|
| University of N.C. | 0.543 | -10.737 | 0.572** | -0.022* | 4.052** | -0.392 | -0.102 | -0.435 | -1.762** |
| NC State University | 0.633 | -10.234 | 0.801** | 0.003 | 3.471** | 0.351 | -1.207 | 1.187 | -0.835 |
| East Carolina University | 0.577 | -9.281 | 0.511** | -0.007 | 3.972** | -0.145 | -0.984 | 1.494 | -1.181* |
| Appalachian State | 0.599 | -10.992 | 0.503** | 0.005 | 1.608* | -0.865** | 0.226 | 1.468 | -1.017 |
| UNC - Asheville | 0.382 | -8.731 | 0.445** | -0.012 | 0.443 | -0.823** | -0.608 | -2.696 | -1.096 |
| UNC - Wilmington | 0.478 | -8.897 | 0.331** | -0.018** | 2.850** | -0.946** | -1.923* | 0.392 | -0.767 |
| UNC - Greensboro | 0.501 | -10.734 | 0.625** | 0.022** | -1.252 | -0.666* | -0.767 | 0.133 | -1.395* |
| UNC - Charlotte | 0.604 | -9.897 | 0.197** | -0.012 | 4.814** | -0.952** | -2.985** | -0.204 | 0.337 |
| Western Carolina | 0.588 | -10.922 | 0.602** | -0.038** | 3.831** | -0.982** | -2.382* | 5.282 | -1.371* |
| Fayetteville State | 0.626 | -10.640 | 0.523** | -0.034** | 2.591** | -1.172** | 0.031 | -0.352 | -1.682** |
| NC Central University | 0.280 | -8.003 | 0.062 | -0.012 | 0.606 | -1.081** | -0.995 | 4.542 | -0.292 |
| UNC - Pembroke | 0.481 | -6.572 | 0.074 | -0.0001 | 0.451 | -0.578* | -1.682* | -1.354 | 3.487** |
| NC School of the Arts | 0.369 | -6.392 | 0.343** | -0.007 | 1.330* | 0.135 | 0.540 | -3.180 | 0.050 |
| Elizabeth City State | 0.468 | -7.943 | -0.463** | -0.058** | 1.782 | -0.674** | -0.602 | 5.052 | -2.251** |
| Winston Salem State | 0.523 | -10.776 | 0.610** | -0.058** | 0.400 | -1.372** | -2.147 | 2.998 | -1.976** |

* Significant at p > 0.05

** Significant at p > 0.01

**TABLE 4**

**ESTIMATED EFFECT OF THE ELIGIBLE POPULATION FACTOR (log HSSG)**

| Institutional Grouping | Coefficient | t |
|---|---|---|
| Group I | 0.642 | 11.71 |
| Group II | 0.520 | 12.81 |
| Group III | 0.493 | 9.67 |
| Statewide | 0.486 | 17.77 |

**TABLE 5**

**ESTIMATED EFFECT OF EDUCATIONAL BACKGROUND FACTORS**

| Institutional Grouping | NCCT | | EDUL | |
|---|---|---|---|---|
| | Coef. | t | Coef. | t |
| Group I | -0.007 | -1.40 | 4.084 | 6.87 |
| Group II | -0.0002 | -0.03 | 1.634 | 3.72 |
| Group III | -0.023 | -4.72 | 3.983 | 7.21 |
| Statewide | -0.014 | -5.33 | 2.553 | 8.64 |

**TABLE 6**

**ESTIMATED EFFECT OF THE FAMILY INCOME FACTOR (log INCOME)**

| Institutional Grouping | Coefficient | t |
|---|---|---|
| Group I | -0.233 | -0.91 |
| Group II | 0.066 | 0.34 |
| Group III | 0.212 | 0.86 |
| Statewide | 0.009 | 0.07 |

**TABLE 7**

**ESTIMATED EFFECT OF COST FACTORS (log PRICE, WAGES, URATE)**

| Institutional Grouping | Log PRICE | | WAGES | | URATE | |
|---|---|---|---|---|---|---|
| | Coef. | t | Coef. | t | Coef. | t |
| Group I | -0.154 | -0.82 | -0.378 | -0.54 | 0.482 | 0.22 |
| Group II | -1.802 | -8.63 | 0.312 | 0.61 | -0.666 | -0.42 |
| Group III | -1.723 | -10.54 | -0.891 | -1.38 | 1.118 | 0.55 |
| Statewide | -1.133 | -12.87 | -0.191 | -0.55 | 0.614 | 0.58 |

**TABLE 8**

**ESTIMATED EFFECT OF THE COUNTY CHARACTERISTICS FACTOR (AGIND)**

| Institutional Grouping | Coefficient | t |
|---|---|---|
| Group I | -1.251 | -3.25 |
| Group II | -1.012 | -3.55 |
| Group III | -0.866 | -2.43 |
| Statewide | -0.798 | -4.17 |

**TABLE 9**

**EXPLANATORY POWER OF THE GENERAL ENROLLMENT MODEL**

| Institutional Grouping | $R^2$ | F-Value | df |
|---|---|---|---|
| Group I | 0.499 | 49.73 | 399 |
| Group II | 0.482 | 62.24 | 535 |
| Group III | 0.556 | 62.54 | 399 |
| Statewide | 0.327 | 123.35 | 2,031 |

## TABLE 10

## CORRELATIONS BETWEEN INDEPENDENT VARIABLES

| | HSSG | NCCT | EDUL | INCOME | PRICE | WAGES | URATE | AGIND |
|---|---|---|---|---|---|---|---|---|
| NCCT | 0.318 | | | | | | | |
| EDUL | 0.472 | 0.598 | | | | | | |
| INCOME | 0.555 | 0.511 | 0.657 | | | | | |
| PRICE | -0.008* | 0.028* | -0.055 | -0.045 | | | | |
| WAGES | 0.426 | 0.331 | 0.433 | 0.646 | -0.014* | | | |
| URATE | -0.252 | -0.343 | -0.291 | -0.363 | 0.030* | -0.313 | | |
| AGIND | 0.053 | -0.126 | -0.211 | -0.116 | 0.027* | -0.072 | 0.265 | |

* Not significant for $p < 0.05$

Note: Correlations and significance levels are for the statewide model. All coefficients are the same for all variables except PRICE across all groupings and individual models; significances, however, do differ for some coefficients due to the different 'n' values for the various institutional groupings and individual models.

## TABLE 11

## CORRELATION OF INDEPENDENT VARIABLES WITH DEPENDENT

| Independent Variable | Group I | Group II | Group III | Statewide |
|---|---|---|---|---|
| HSSG | 0.623 | 0.591 | 0.524 | 0.468 |
| NCCT | 0.301 | 0.320 | 0.156 | 0.142 |
| EDUL | 0.556 | 0.458 | 0.521 | 0.377 |
| INCOME | 0.440 | 0.440 | 0.451 | 0.327 |
| PRICE | -0.042* | -0.252 | -0.463 | -0.258 |
| WAGES | 0.306 | 0.322 | 0.274 | 0.229 |
| URATE | -0.214 | -0.244 | -0.164 | -0.142 |
| AGIND | -0.160 | -0.151 | -0.146 | -0.099 |

* Not significant for $p < 0.05$

## TABLE 12

## ESTIMATED EFFECT OF THE ELIGIBLE POPULATION FACTOR (log HSSG)

| Institution | Coefficient | t |
|---|---|---|
| University of NC at Chapel Hill | 0.572 | 6.41** |
| NC State University | 0.801 | 9.92** |
| East Carolina University | 0.511 | 7.02** |
| Appalachian State University | 0.503 | 6.65** |
| UNC - Asheville | 0.445 | 5.37** |
| UNC - Wilmington | 0.331 | 4.43** |
| UNC - Greensboro | 0.625 | 7.36** |
| UNC - Charlotte | 0.197 | 2.81** |
| Western Carolina University | 0.602 | 6.80** |
| Fayetteville State University | 0.523 | 6.75** |
| NC Central University | 0.062 | 0.82 |
| UNC - Pembroke | 0.074 | 1.32 |
| NC School of the Arts | 0.343 | 5.53** |
| Elizabeth City State University | 0.463 | 5.30** |
| Winston Salem State University | 0.610 | 6.14** |

* Significant at $p < 0.05$

**Significant at $p < 0.01$

## TABLE 13

## ESTIMATED EFFECT OF EDUCATIONAL BACKGROUND/INCOME FACTORS (NCCT, EDUL)

| | NCCT | | EDUL | |
|---|---|---|---|---|
| Institution | Coef. | t | Coef. | t |
| University of NC at Chapel Hill | 0.022 | -2.38* | 4.052 | 4.13** |
| NC State University | 0.003 | 0.53 | 3.471 | 4.04** |
| East Carolina University | -0.007 | -1.04 | 3.972 | 4.72** |
| Appalachian State University | 0.005 | 0.73 | 1.608 | 2.02* |
| UNC - Asheville | -0.012 | -1.51 | 0.443 | 0.50 |
| UNC - Wilmington | -0.018 | -2.47** | 2.850 | 3.62** |
| UNC - Greensboro | 0.022 | 2.68** | -1.252 | -1.41 |
| UNC - Charlotte | -0.012 | -1.72 | 4.814 | 6.18** |
| Western Carolina University | -0.038 | 4.42** | 3.831 | 3.94** |
| Fayetteville State University | -0.034 | -4.41** | 2.591 | 3.03** |
| NC Central University | -0.012 | -1.64 | 0.606 | 0.72 |
| UNC - Pembroke | -0.0001 | -0.02 | 0.451 | 0.74 |
| NC School of the Arts | -0.007 | -1.22 | 1.330 | 1.98* |
| Elizabeth City State University | -0.058 | -6.38** | 1.782 | 1.84 |
| Winston Salem State University | -0.058 | -6.00** | 0.400 | 0.36 |

* Significant at $p < 0.05$

**Significant at $p < 0.01$

**TABLE 14**

**ESTIMATED EFFECT OF COST FACTORS (log BUDCON, WAGES, URATE)**

| Institution | Log BUDCON | | WAGES | | URATE | |
|---|---|---|---|---|---|---|
| | Coef. | t | Coef. | t | Coef. | t |
| UNC - CH | -0.392 | -1.07 | -0.102 | -0.08 | -0.435 | -0.12 |
| NCSU | 0.351 | 0.98 | -1.207 | -1.21 | 1.187 | 0.37 |
| ECU | -0.145 | -0.60 | -0.894 | -1.02 | 1.494 | 0.51 |
| ASU | -0.865 | -3.03** | 0.226 | 0.23 | 1.468 | 0.48 |
| UNC - A | -0.823 | -2.46** | -0.608 | -0.61 | -2.696 | -0.81 |
| UNC - W | -0.946 | -4.32** | -1.923 | -2.17 | 0.392 | 0.12 |
| UNC - G | -0.666 | -2.07* | -0.767 | -0.74 | 0.133 | 0.03 |
| UNC - C | -0.952 | -5.55** | -2.985 | -3.44** | -0.204 | -0.06 |
| WCU | -0.982 | -3.71** | -2.382 | -2.28* | 5.282 | 1.53 |
| FSU | -1.172 | -5.84** | 0.031 | 0.02 | 0.352 | -0.11 |
| NCCU | -1.081 | -5.01** | -0.995 | -1.13 | 4.542 | 1.54 |
| UNC - P | -0.578 | -2.26* | -1.682 | -2.36* | -1.354 | -0.61 |
| NCSOA | 0.135 | 0.26 | 0.540 | 0.68 | -3.180 | -1.31 |
| ESCU | -0.674 | -3.21** | -0.602 | -0.55 | 5.052 | 1.41 |
| WSSU | -1.372 | -4.56** | -2.147 | -1.83 | 2.998 | 0.77 |

* Significant at $p < 0.05$

** Significant at $p < 0.01$

## TABLE 15

## ESTIMATED EFFECT OF THE COUNTY CHARACTERISTICS FACTOR (AGIND)

| Institution | Coefficient | t-Value |
|---|---|---|
| UNC - Chapel Hill | -1.762 | -2.74** |
| NC State University | -0.835 | -1.47 |
| East Carolina University | -1.181 | -2.24* |
| Appalachian State | -1.017 | -1.88 |
| UNC - Asheville | -1.096 | -1.85 |
| UNC - Wilmington | -0.767 | -1.44 |
| UNC - Greensboro | -1.395 | -2.32* |
| UNC - Charlotte | 0.337 | 0.65 |
| Western Carolina | -1.371 | -2.22* |
| Fayetteville State | -1.682 | -2.98** |
| NC Central University | -0.292 | -0.55 |
| UNC - Pemborke | 3.487 | 8.07** |
| NC School of the Arts | 0.050 | 0.11 |
| Elizabeth City State | -2.251 | -3.54** |
| Winstom Salem State | -1.976 | -2.85** |

* Significant at $p < 0.05$

** Significant at $p < 0.01$

## TABLE 16

## EXPLANATORY POWER OF THE GENERAL INSTITUTIONAL MODEL

| Institution | $R^2$ | F-Value | df |
|---|---|---|---|
| UNC - Chapel Hill | 0.543 | 21.74 | 128 |
| NC State University | 0.633 | 31.51 | 128 |
| East Carolina University | 0.577 | 24.95 | 128 |
| Appalachian State | 0.599 | 27.32 | 128 |
| UNC - Asheville | 0.382 | 11.30 | 128 |
| UNC - Wilmington | 0.478 | 16.73 | 128 |
| UNC - Greensboro | 0.501 | 18.38 | 128 |
| UNC - Charlotte | 0.604 | 29.92 | 128 |
| Western Carolina | 0.588 | 26.10 | 128 |
| Fayetteville State | 0.626 | 30.62 | 128 |
| NC Central University | 0.280 | 7.11 | 128 |
| UNC - Pemborke | 0.481 | 16.94 | 128 |
| NC School of the Arts | 0.369 | 10.67 | 128 |
| Elizabeth City State | 0.468 | 16.11 | 128 |
| Winstom Salem State | 0.523 | 20.02 | 128 |

**TABLE 17**

**CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND THE DEPENDENT VARIABLE AND BETWEEN INDEPENDENT VARIABLES AND BUDCON BY INSTITUTIONS**

| Institution | HSSG | NCCT | EDUL | BUDCON | WAGES | URATE | AGIND |
|---|---|---|---|---|---|---|---|
| UNC | | | | | | | |
| Log E | 0.620 | 0.257 | 0.580 | -0.480 | 0.363 | 0.252 | -0.224 |
| BUDCON | -0.476 | -0.510 | -0.630 | --- | -0.573 | -0.373 | 0.126* |
| NCSU | | | | | | | |
| Log E | 0.737 | 0.373 | 0.580 | -0.456 | 0.297 | -0.216 | -0.102* |
| BUDCON | -0.547 | -0.528 | -0.643 | --- | -0.627 | 0.372 | 0.131* |
| ECU | | | | | | | |
| Log E | 0.642 | 0.334 | 0.632 | -0.468 | 0.322 | -0.220 | -0.188 |
| BUDCON | -0.436 | -0.380 | -0.627 | --- | -0.516 | 0.353 | 0.127* |
| ASU | | | | | | | |
| Log E | 0.670 | 0.447 | 0.584 | -0.612 | 0.446 | -0.267 | -0.154* |
| BUDCON | -0.483 | -0.548 | -0.585 | --- | -0.576 | 0.317 | 0.115* |
| UNC - A | | | | | | | |
| Log E | 0.546 | 0.165 | 0.355 | -0.454 | 0.286 | -0.262 | -0.155* |
| BUDCON | -0.486 | -0.414 | -0.582 | --- | -0.554 | 0.376 | 0.140* |
| UNC - W | | | | | | | |
| Log E | 0.525 | 0.223 | 0.520 | -0.533 | 0.240 | -0.186 | -0.156* |
| BUDCON | -0.451 | -0.453 | -0.543 | --- | -0.493 | 0.297 | 0.117* |
| UNC - G | | | | | | | |
| | 0.636 | 0.424 | 0.392 | -0.492 | 0.316 | -0.271 | -0.144* |
| BUDCON | -0.484 | -0.527 | -0.583 | --- | -0.552 | 0.357 | 0.131* |
| UNC - C | | | | | | | |
| Log E | 0.469 | 0.391 | 0.684 | -0.632 | 0.255 | -0.212 | -0.078* |
| BUDCON | -0.403 | -0.527 | -0.613 | --- | -0.534 | 0.318 | 0.107* |

* Not significant for $p < 0.05$

**TABLE 17, Continued.....**

**CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND THE DEPENDENT VARIABLE AND BETWEEN INDEPENDENT VARIABLES AND BUDCON BY INSTITUTIONS**

| Institution | HSSG | NCCT | EDUL | BUDCON | WAGES | URATE | AGIND |
|---|---|---|---|---|---|---|---|
| WCU | | | | | | | |
| Log E | 0.598 | 0.052* | 0.487 | -0.567 | 0.223 | -0.073* | -0.146* |
| BUDCON | -0.522 | -0.295 | -0.596 | --- | -0.526 | 0.257 | 0.134* |
| FSU | | | | | | | |
| Log E | 0.575 | 0.083* | 0.490 | -0.607 | 0.386 | -0.242 | -0.287 |
| BUDCON | -0.320 | -0.210 | -0.467 | --- | -0.457 | 0.292 | 0.156* |
| NCCU | | | | | | | |
| Log E | 0.225 | -0.037* | 0.242 | -0.473 | 0.118* | 0.022* | -0.067* |
| BUDCON | -0.472 | -0.242 | -0.574 | --- | -0.482 | 0.280 | 0.141* |
| UNC - P | | | | | | | |
| Log E | 0.222 | 0.061* | 0.042* | -0.324 | -0.012* | 0.063* | 0.632 |
| BUDCON | -0.544 | -0.491 | -0.554 | --- | -0.601 | 0.291 | -0.173 |
| NCSOA | | | | | | | |
| Log E | 0.575 | 0.198 | 0.394 | -0.376 | 0.324 | -0.250 | -0.023* |
| BUDCON | -0.555 | -0.511 | -0.657 | --- | -0.646 | 0.363 | 0.116* |
| ECSU | | | | | | | |
| Log E | 0.338 | -0.294 | 0.156* | -0.366 | 0.132* | 0.006* | -0.205 |
| BUDCON | -0.292 | -0.132* | -0.422 | --- | -0.470 | 0.303 | 0.165 |
| WSSU | | | | | | | |
| Log E | 0.462 | -0.226 | 0.174 | -0.458 | 0.126* | -0.021 | -0.137* |
| BUDCON | -0.523 | -0.300 | -0.600 | --- | -0.531 | 0.260 | 0.134* |

* Not significant for $p < 0.05$

**TABLE 18**

**STATEWIDE $R^2$ MEASURES FOR THE LOGIT, PROBIT**

**AND LINEAR PROBABILITY MODELS**

| $R^2$ Measures | Logit Model | Probit Model | Linear Probability Model |
|---|---|---|---|
| Effron's $R^2$ | 0.369 | 0.313 | 0.302 |
| Cragg-Uhler's $R^2$ | 0.294 | 0.299 | 0.280 |
| McFadden's $R^2$ | 0.317 | 0.382 | 0.313 |

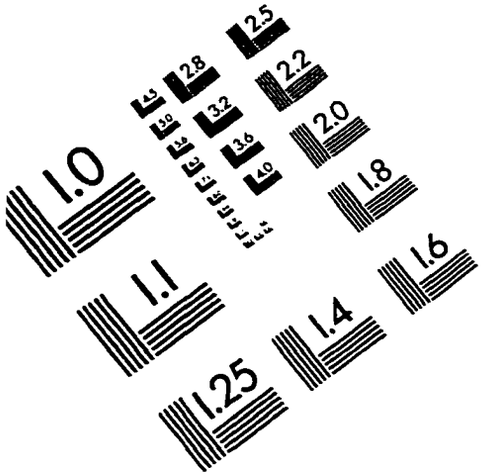
**TABLE 19**

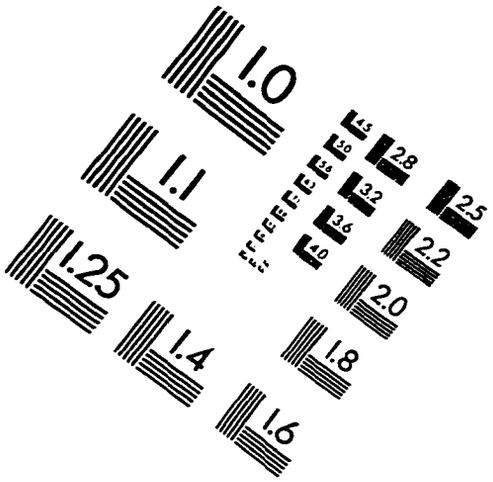
**COMPARISON OF THE LOGIT, PROBIT, AND LINEAR PROBABILITY MODELS**

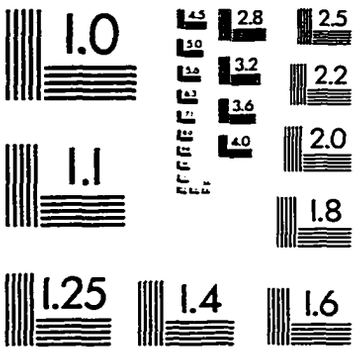
| Variable | Logit Model | Probit Model | Linear Probability Model |
|---|---|---|---|
| AI | 2.254 (4.60) | 2.030 (4.73) | 1.489 (4.69) |
| DMP | -1.170 (5.57) | -1.773 (5.67) | -1.509 (5.74) |
| DF | 0.563 (0.87) | 0.206 (0.95) | 0.140 (0.78) |
| DR | -0.240 (1.60) | -0.279 (1.66) | -0.266 (1.84) |
| DS | -0.222 (1.51) | -0.274 (1.70) | -0.238 (1.75) |
| DA | -1.463 (3.34) | -1.570 (3.29) | -1.426 (3.52) |
| CNWP | -2.028 (0.80) | -2.360 (0.85) | -1.762 (0.74) |
| CMFI | 0.149 (0.20) | 0.194 (0.25) | 0.150 (0.23) |
| CA | -0.386 (1.25) | -0.425 (1.26) | -0.393 (1.34) |
| Constant | 0.363 | 0.488 | 0.501 |

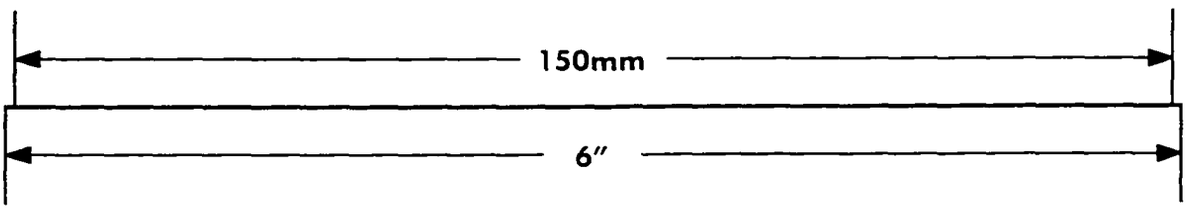
Figures on parentheses are t-ratios, not standard errors.

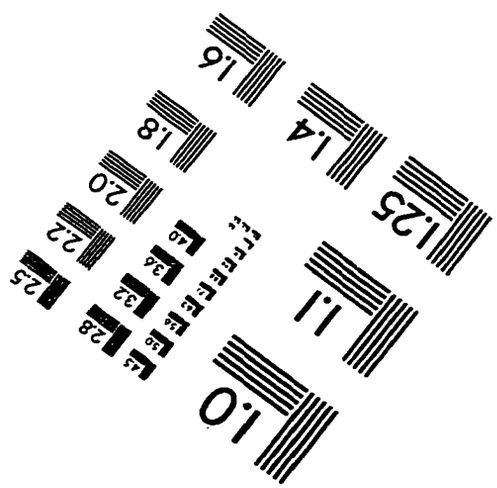
# IMAGE EVALUATION
# TEST TARGET (QA-3)

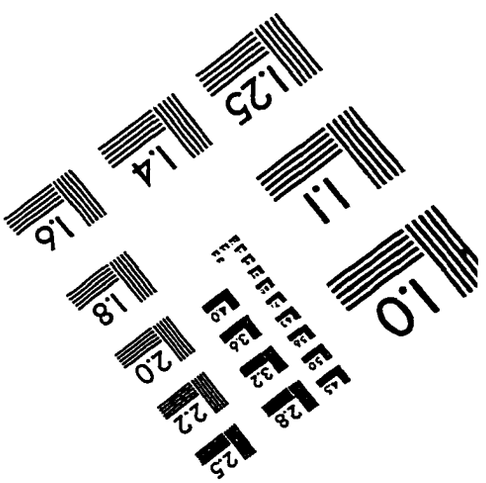
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