A PRODUCTION FUNCTION FOR VOCATIONAL EDUCATION IN OKLAHOMA

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PREFACE

This research was performed in order to explain the relationship between scores from performance-based vocational competency exams and various inputs utilized in the production of vocational education in Oklahoma. The afore-mentioned competency exam is a relatively new development in the measurement of vocational student outcomes. Specifically, the objective of this study was to identify those factors which could be successful in raising the competency exam scores. For this analysis, ordinary least squares (OLS) multiple regression analysis was utilized for data in three separate test groups.

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CHAPTER I

INTRODUCTION

Can "throwing money" into a school system improve student performance? An intuitive response to this question is probably, "Yes." The first comprehensive study of this question, however, presented results opposite to the predominant line of thought. In 1966, that first study, the "Equality of Educational Opportunity" report by James S. Coleman, caused quite a stir among educators and economists. Educators could not believe that additional funding, which could buy state-of-the-art equipment and lure the best teachers to their schools, would not have a positive impact on student performance. For economists, it was a discovery that there were possibly zero marginal returns associated with marginal dollars to the educational process.

Over the years, research of this topic has created a core of accepted variables that often have an impact on student performance as usually measured by test scores. This core of variables includes: student socio-economic characteristics, school and teacher characteristics, and peer group characteristics (for instance the percent of the school that is economically disadvantaged).

Even though substantial evidence exists concerning the impact of these variables on student performance in public secondary school settings, a major gap exists in our knowledge. How do these and other variables affect vocational education? This question has been on the minds of vocational educators at the Oklahoma Department of Vocational and Technical Education (ODVTE) for several years. With the recent advent of the performance-based occupational competency exam that measures the skill of a vocational student in his/her chosen occupation, vocational educators have become especially curious to know which inputs to vocational education affect those test scores.

With the assistance of the ODVTE, which has provided several sets of occupational competency test scores, compilations of student characteristics, cost reports, and other data, this study will attempt to answer the question, "Which inputs to vocational education can raise scores on the occupational competency exam?" Scores from the following three occupations were obtained: General Electronics Technician (containing scores from area vocational schools only), Marketing Education-Salesperson, and Marketing Education-Manager Trainee (both containing scores from area vocational schools and from comprehensive high schools). Due to the experimental nature of these tests in Oklahoma during the 1993-94 school year, these are essentially the only occupations available that provide a usable sample. Tests were certainly administered for other occupations; however, in many cases the number of students taking the exam was too small for statistical purposes. It should be noted here that in 1993-94, these tests were in their infancy. During the 1993-1998 period, this process has, in fact, matured so that many more tests are offered to many more students.

At no time was the researcher informed of the identity of the students whose scores were used. In addition, steps were taken to insure that the individual schools and teachers remained completely anonymous.

Since this study is unique in that it addresses the relationship between inputs and outputs in vocational education, as opposed to secondary education, it is appropriate to explore the origins of vocational education in general and in Oklahoma specifically. Chapter II will address the history of vocational education. Chapter III will introduce the topic of production functions, specifically production functions with respect to the educational process. An in-depth look at inputs and outputs involved in education will follow. Chapter IV describes the specific methodology utilized for this study. The occupational competency tests will be described in detail. The choice of specific variables and model specification will be justified in this chapter. Chapter V will present the results of the various regressions, and Chapter VI will present conclusions and policy implications of the results.

CHAPTER II

A HISTORY OF VOCATIONAL EDUCATION IN OKLAHOMA

From the Guilds to Federal Law

Vocational education is defined as the "acquisition of a skill or trade by actual experience in a learning environment" (Tyson, 1975, p. 1). Given this definition, the earliest form of vocational education is generally recognized to be the apprenticeship system. Apprenticeship appeared in the ancient civilizations of the Egyptians, Babylonians, Hebrews, Romans, and Greeks, but essentially disappeared during the Dark Ages. Formally, apprenticeship appeared in England during the thirteenth century. In this system, a young person would apprentice himself to a skilled tradesman or artisan. The master trained the apprentice in every facet of the chosen profession.

In the latter medieval period, merchants created organizations called guilds. Actually, merchant guilds date as far back as the Norman conquest of England in 1066 (Roberts, 1971), but the guilds began developing through the 13th and 14th centuries as the ongoing division of labor created specific trades (Tyson, 1975). These early guilds often received trade monopolies from the monarchy in exchange for favors or allegiance. Their duties included the regulation of the buying and selling of goods, the times and places of sales, the price of goods, and sales practices. Later, craft guilds would develop and be concerned with the quality and quantity of goods produced by craftsmen.

The guilds of the 13th and 14th centuries essentially provided the only educational opportunity for the working people of the Middle Ages (Roberts, 1971); therefore, a major goal of these organizations was to regulate the apprentice system. Basically, the apprentice signed a contract that bound him to live with his master for a required time (usually seven years) and to obey the master's commands. The apprentice could not marry, behave immorally, or leave the master's service without permission. In return, the master instructed the apprentice in the chosen trade and provided room, board, and clothing. After the completion of the seven years, the master could elevate the apprentice to the status of journeyman. The journeyman lived in the master's house and worked for the master for a fixed wage. After several years of experience, the journeyman might attempt to become a master by performing a "masterpiece" which the guild officers would judge.

This system of apprenticeship required some protection by the guilds. The guilds enforced a number of rules including: 1) The prohibition of one master attracting apprentices from another master; (2) A requirement that all masters receive training before becoming a master; 3) No tradesman could enter a practice without the approval of the guild; and 4) No master could have more than three apprentices.

By the 1600s the guilds had created schools for instruction, and these were the forerunners to modern vocational education schools (Tyson, 1975). The guilds maintained Latin secondary schools for boys who intended to enter a university and train for a profession. They also established apprenticeship schools that offered trade school classes. Associations of craftsmen would maintain these types of schools long after the decline of the guilds (Roberts, 1971).

When the English founded the North American colonies, the notion of apprenticeship came with them. Roberts (1971) notes that the early settlers did not come to the colonies for education; they mainly came to escape religious persecution. Thus, during the 17th century, education was practiced as it was in England. Most of the colonies had laws providing for the teaching of a craft to poor children in order to prevent them from becoming a burden on society. However, in the American colonies, apprentices were often no more than indentured servants (Tyson, 1975). These compulsory apprentices were usually poor children bound by the authorities of their town to a master.

With the advent of the Industrial Revolution, apprenticeship began its decline (Roberts, 1971). Increases in demand for manufactured goods created a demand for laborers to operate manufacturing machinery. Such workers did not require specialized skills, and the master/apprentice relationship soon became obsolete.

This era of American history is associated with the exploitation of workers – especially children – who worked long hours in dangerous conditions for low wages. As public opinion began to grow against such practices, educational leaders began to search for ways to provide educational opportunities to lower class children (Roberts, 1971). The first major steps in this direction were compulsory attendance laws for public schools enacted by all the existing states between 1870 and 1920. With this growth of students, it was soon clear that more schools and teachers were needed. Many educators also began to push for a wider curriculum which would include manual and vocational subjects in order to meet the needs and interests of the new students (Roberts, 1971). In 1880, the first formal "manual training" high school was founded in St. Louis, Missouri in conjunction with Washington University and under the guidance of Professor Calvin M. Woodward. Soon schools followed in Chicago, New Orleans, and Atlanta. In 1885 in Toledo, Ohio, vocational courses were first offered to girls.

The government did not fully involve itself with the provision of vocational education at first. The first move in this direction came during the 1905 Massachusetts legislative session when Governor William L. Douglas appointed a commission to look into the question of industrial education (Hawkins et. al., 1951). Essentially, the Douglas Commission found that there was widespread interest in vocational training, too much literary emphasis in the public schools, and a general feeling that vocational training should be funded, at least in part, by the state. The Commission recommended the creation of new elective industrial classes in the high schools, classes in the principles of agriculture, domestic science, and mechanical arts, and evening courses for those who were already employed full-time.

Based on the recommendations of the Massachusetts Commission, that state began the country's first state system of public vocational education. By 1913, eight other states had followed the example: Connecticut, Maryland, New Jersey, Maine, Michigan, Wisconsin, Indiana, and Illinois.

The 1913 congressional elections saw the topic of vocational education as a hot political issue. In January of 1914, the Smith-Lever Act – providing federal aid for the training of farmers and their families in agriculture and home economics – was passed. Later that month, President Wilson signed a resolution whereby he was authorized to appoint a Commission to study the problems associated with providing federal funding to secondary schools in support of vocational education. By June, the Commission on

National Aid to Vocational Education submitted its report to Congress. The Commission's report recommended immediate federal aid for vocational education.

On February 23, 1917, President Woodrow Wilson signed the Vocational Education Act to provide for vocational education in agriculture, home economics, and trades and industry. "The passage of this act began an era – the era of modern vocational education" (Tyson, 1975). This act is better known as the Smith-Hughes Act (passed in Congress on April 20, 1916) after its authors: Senator Hoke Smith and Representative Dudley Hughes, both of Georgia. The act provided for federal funds to be provided for expenses and teacher training in the above mentioned programs. The following restrictions governed the use of federal funds: 1) States had to provide matching funds; 2) State plans had to be submitted and were subject to approval by the national government; 3) Funds had to be used for students of less than college level; and 4) The primary goal of the state program had to be to train individuals for useful – gainful – employment. A Federal Board of Vocational Education was created to assure compliancy by the states with the regulations of the act. Within ten months, all 48 states had accepted the provisions of the act.

Vocational Education in Oklahoma

On March 24, 1917, Oklahoma passed House Bill No. 213 accepting the federal offer. The act also created the State Board of Vocational Education. Actually, 1917 was not the beginning of Oklahoma's involvement in vocational education. The Constitution of the State of Oklahoma provides for the teaching of agriculture, horticulture, stock feeding, and domestic science. After July 1, 1909, the constitution required that teachers take an exam to become certified to teach the above courses. It was the only state constitution to provide for such, and state education officials were proud of this fact (Tyson, 1975).

Unfortunately, a lack of state funds shortly thereafter caused the interest in vocational education to wane. In the summer of 1911, Oklahoma A&M College and the Department of Education undertook a campaign to raise interest in vocational education. By 1916, several strong programs were in place, including those in Ponca City, Drumright, and Checotah. Thus, in 1917, Oklahoma was prepared to submit a State Plan for Oklahoma that was approved by the Federal Board of Vocational Education in November of 1917.

Stewart (1982) claims that the next dominant change in scope for vocational education in Oklahoma came in 1963 with the Vocational Act of 1963 and its subsequent amendments in 1968 and 1976. The 1963 action broadened the scope of vocational education to focus attention on economically depressed areas, persons handicapped or disadvantaged, adult training, initial employment and upgrading, and inmate skill training. The amendment of 1976 emphasized social aspects such as language training for those with limited English proficiency, attempts to reduce sexual bias, assistance for displaced homemakers, and greater flexibility in adapting to changing labor market conditions and technological changes in the work force (Stewart, 1982).

1968 was a year of change for vocational education in Oklahoma. Since 1929, the Division of Vocational Education had been a member of the State Department of Education. On July 1, 1968, vocational education was separated from the Department of Education and the State Department of Vocational and Technical Education was created. The State Director of Vocational Education, Dr. Francis T. Tuttle, oversaw the administration of this newly created institution. Dr. Tuttle and his Assistant Directors were located in the central offices of vocational and technical education in Stillwater, where they are still located.

Today, Oklahoma's system of vocational and technical education is far-reaching. Vocational education programs are found in *comprehensive schools* in 399 sites. These include middle schools, junior high schools, and high schools. The Oklahoma network of *area vo-tech schools* (AVTS) includes 29 area school districts at 54 different campuses across the state.

The *skills centers* serve adult Oklahomans in a variety of locations including 13 skills centers located on prison grounds. In fiscal year (FY) 1997, 1,319 inmates enrolled in one of 26 areas of training including: horticulture, carpentry, air conditioning and heating, and automobile service and technology. Many of these inmates will be placed in jobs either within the correctional system or on the outside following their release from prison.

On-site training is also provided for businesses, industries, and labor (ODVTE, 1990). This area is a growing market for Oklahoma's vocational system. The Training for Industry Program (TIP) serves companies that must equip their workers with new skills. In FY 1997, there were over 34,000 students served by TIPs in operation by the Oklahoma Vo-tech. This compares to about 2000 students in FY 1987.

Oklahoma Vo-Tech offers seven major occupational training areas: Agricultural Education, Vocational Business Education, Health Occupations Education, Family and Consumer Sciences, Marketing Education, Technology Education, and Trade and Industrial Education. About 406,000 students (both full and part time) were enrolled in vocational education programs in fiscal year 1997. Of those, 103,800 were secondary students and 275,000 were adult students. The most popular areas of enrollment in FY 1997 were:

Family and Consumer Sciences with enrollment of 45,700, Agricultural Education with enrollment of 27,000, and Technology Education with enrollment of 26,800.

Based on trends in demographics, the economy, education, the work force, and technology, the ODVTE (1993) believes the following statements to be true:

1. We operate as partners in integrated educational and economic development systems;
2. Business and industry is our ultimate customer and partner as we continuously improve the work force and create high-performance organizations;
3. There is a critical relationship between the quality of our schools, the preparation of our work force, and the health of our economy.

Clearly, economic development is at the heart of the purpose for vocational-technical education in Oklahoma. In fact, the 1993 mission statement for the ODVTE was, "We prepare Oklahomans to succeed in the workplace." Given such a mission, an ongoing question for administrators at the ODVTE must be, "What is the best way to prepare workers for the workforce?" Indeed, this does seem to reflect the attitudes of vocational educators both on a state and national level.

A buzzword in vocational education literature today is "outcomes." Synonymous phrases include educational indicator, quality indicator, outcome indicator, performance standard, and performance measure. Asche (1990, pp. 3-4) claims that "quality or performance indicators have suddenly become the nation's barometer of education wellness." Essentially, educators would like to have an objective way to measure how well they are doing.

Traditionally, vocational education has been judged based on labor market outcomes that include job placement and earnings. The current trend is to attempt to define learning outcomes. A popular mechanism for doing this is the occupational competency test designed to measure the competency attainment of a student in a particular occupation. This mood has penetrated Oklahoma's vocational system. In fact, Oklahoma is one of the leaders in occupational competency testing. By 1989, the ODVTE had begun to phase in a competency testing system approved by the State Board of Vocational and Technical Education in order to remain in compliance with the Carl D. Perkins Vocational and Applied Technology Act of 1990. Section 115 (b) (2) of the Act:

> requires one or more measures of performance, which shall include: (a) competency attainment and (b) job or work skill attainment or enhancement including student progress in achieving occupational skills necessary to obtain employment in the field for which the student has been prepared, including occupational skills in the industry the student is preparing to enter.

A natural continuation of the collection of outcomes is to begin to question how to improve such outcomes. Even though occupational competency tests are still not available to all occupations, Oklahoma educators were already asking in 1993 what could be done to improve scores. Together, the Carl D. Perkins Act and the ODVTE Occupational Testing Process have set the stage for this study. In economic terminology, the question for study is, "What combination of inputs can be employed by the ODVTE in order to produce the best combination of outputs from the vocational education process?" Imbedded in this question is the concept of an economic production function – a relationship describing how inputs are transformed into outputs. To define the production function for a process is to point the way toward improvement of the outcome. This study, therefore, has been titled, *A Production Function for Vocational Education in Oklahoma*.

CHAPTER III

THE EDUCATIONAL PRODUCTION FUNCTION

An Introduction to the Production Function in Education

Production functions have been defined in a variety of ways. It is a "formula describing the way in which the firm transforms flows of raw materials, labor, and machine services into a flow of final product" (Brown and Saks, 1981, p. 219). It "identifies the maximum quantity of a commodity that can be produced per time period by each specific combination of inputs" (Browning and Browning, 1986, p. 167). To put it simply, a production function is nothing more than the relationship between inputs and outputs.

In our microeconomics classrooms, we often characterize the production function by claiming that some amount of capital, K, and some amount of labor, L, will create a specific amount of output, X.

$$X = f(K, L)$$

Obviously, the production function is a more complex function in reality. Even so, manufacturing enterprises, for example, are quite capable of defining them (often with the assistance of engineers). For instance, consider the building of a wooden chair. A carpenter may be able to describe his production function as easily as two hours of labor, six 2x4 wooden planks, and 14 nails will make one wooden chair. If only it were as easy for the professional educator to describe his/her production!

The main difficulty that educators face in defining their production function is that in many situations it is unknown how inputs affect the output or even *which* inputs are effective. Even when inputs are known to be important, it is often unclear how to measure their impact. For example, the teacher is surely an important input in the educational process, yet there is no consensus about how best to measure his/her contribution.

Difficult as they are to define, Hanushek (1986, p. 1149) claims that educational production functions may actually be more important (or socially relevant) than those of other industries due to their "immediate application to policy considerations." He claims that estimated educational production functions have been the basis of heated policy debates in judicial and legislative settings. The state of Oklahoma provides a perfect example of such a debate. Critics of Oklahoma's House Bill No. 1017, which, among other things, raised teachers' salaries, pointed to such production functions which indicated that simply appropriating larger amounts of money to education has not significantly improved school outcomes. Although Hanushek does not say so, the implication of this distinction of educational production functions is that researchers must be extraordinarily careful about how they define relationships and measure inputs involved in the process. It also means that results of any one study should not be regarded as "proof" of a relationship.

Despite the difficulties involved in estimating an educational production function, it has been attempted many times. One of the earliest and most comprehensive studies was the Coleman Report of 1966, directed by James S. Coleman. The "Equality of Educational Opportunity" report attempted to show the effect of both school and non-school factors on the achievement of 600,000 students. The report has been the subject of much debate, mainly because it contended that school factors had little to do with achievement (Cohn and

Geske, 1990). Non-school factors were more important. The impression left by the Coleman Report was that teachers did not matter (Hanushek, 1986). While subsequent studies have found results that override some of the Coleman results, it still remains true that many popularly accepted "inputs" have failed to show any significant relationship with output. Inputs and outputs will be discussed at length in a later section.

Since the publication of the Coleman Report in 1966, Hanushek (1986) has documented 147 additional studies that have estimated educational production functions. It would be redundant to fully review these studies. Cohn and Geske (1990) also have an extensive review. Quite recently, Deller and Rudnicki (1993) found that Maine Public Schools experience production inefficiencies. Callan and Santerre (1990) find similar results in Connecticut. Brown (1991) finds that girls may be inherently better in reading while boys are better in math, despite reallocation of time by the teacher. Link and Mulligan (1991) find that black students do better in classes that are largely black as compared to classes that are largely white. Andrews, Fayissa, and Tate (1991) find community and family inputs to be highly significant. Gyimah-Brempong and Gyapong (1991) have similar findings. There appear to be no published production function studies that are concerned primarily with vocational education.

Outputs of Vocational Education

In the example used earlier, the wooden chair, it was quite clear the manner in which the inputs were used to create the final output. In the educational process, relationships are a bit more fuzzy (an understatement). In general, educators do not understand their own production process – or they have different views of it.

If, for example, a group of twenty educators was asked to define their inputs, their product, and their customers, the result would likely be twenty sets of answers. However, there are, in general, two lines of thought. One group of educators, often comprised of teachers, will insist that students do not represent the output of education. Instead students are the primary customers of education. Another equally adamant group, often comprised of administrators, claims that students are, in fact, the product of education, while parents, industry, and taxpayers are the main customers. Officially, the Oklahoma Department of Vocational and Technical Education has adopted the latter viewpoint. ODVTE's Strategic Plan states the official belief that "Business and industry is our ultimate customer." From an economic standpoint, this statement is probably correct.

To understand why the student is the output of education, consider the following situation from a manufacturing standpoint. The raw material enters the production process. Using the capital and labor available, the raw material is transformed into an output ready for use by a customer who will value the product. Now turn this into an educational analogy. The raw material is the student who enters the educational system lacking in certain types of knowledge (for example, vocational skills). Utilizing schools and learning materials (capital) and teachers (labor), that student is transformed into a graduate with those skills. The transformation complete, business and industry will place a value on the final product, and the graduate will be hired (or not, depending on the value) and take his/her place in society.

The main criticism to this approach or philosophy is that it appears to ignore the needs of the student. The student is treated as a thing, an inanimate object with no say in his/her educational development. While this may seem like a good argument on the surface, it really is not valid. Refer again to the analogy. When raw material enters the production process, representatives of the firm will test the material, study it, and then decide how it should be used. In the chair example, the carpenter may discover some wood to be remarkably strong. This wood he will use to brace the chair. Other wood may be weak. The carpenter may set such wood aside for another purpose. The point is that the carpenter did not ignore his raw material. He analyzed the strengths and weaknesses of the material and approached his construction with these firmly in mind. A teacher might do the same thing with his/her students. The teacher will discover the strengths and weaknesses of the individual student and teach accordingly. Of course, the student must take some responsibility as well. He/she must show and maintain their true ability and make conscious choices about what they want to get out of the educational process, but this does not invalidate the analogy.

For purposes of this study, the student will, in fact, be considered the output of the educational process. This declaration, however, raises a whole new set of questions and debates. The most important, "How do we define and measure the output?"

Cohn and Geske (1990) describe two types of outcomes of education – consumption and investment outcomes. The **consumption outcome** refers to the idea that students gain satisfaction from participating in education. This may seem incredible, but sports, extracurricular activities, and socializing opportunities do seem to be a part of the consumption benefits of school. Cohn and Geske (1990, p. 164) note that the families of students also gain consumption benefits from schools because they are "relieved of the responsibility toward the youngster during school hours."

The **investment outcome of schooling** assumes that a student's productive skills will be improved due to his/her education, consequently increasing the student's value to society. At the individual level, the most accepted explanation for investment in education is referred to as the human capital approach. In its simplest form, the approach states that investment in education leads to increased productivity which will lead to higher earnings. This is an extension of marginal productivity theory that argues that more productive workers add a higher marginal contribution to the revenues of the firm and thus should be paid more, other things equal.

Sparked by *Human Capital* authored by Gary Becker (1964) and Jacob Mincer's *Schooling, Experience, and Earnings* (1974), research in this field was heavy in the 1960s and 1970s. Most researchers attempted to pinpoint the benefits, measured by earnings, for those with education over and above the benefits received by those with less education. Some representative studies include Hu, Lee, and Stromsdorfer (1971), Corazzini (1968), Taussig (1968), Hansen (1963), Carnoy and Marenbach (1975), Solomon and Taubman (1973), etc. No level of education was ignored during this time of heavy research. Hansen (1963) and Hanoch (1967) studied elementary and secondary education, for instance. Carnoy and Marenbach (1975), for example, found the internal rate of return for the investment in secondary education to be 18.9% in 1970.

Solomon and Taubman (1973), Hansen (1963), and Freeman (1977) addressed post-secondary education. Most find a positive return on the investment. Although many studies have confronted the investment in secondary vocational education, they have met with mixed results. Some of the most referenced studies include Corazzini (1968), Taussig (1968), and Hu, Lee, and Stromsdorfer (1971).

Studies attempting to analyze monetary returns to schooling have slacked off since the mid-1980s. Rate-of-return studies do continue, but most of them seem to focus on specific populations or international examples. For instance, Ryoo et al. (1993) examine rates of return to pre-university schooling in Korea. Bevc (1993) analyzes similar issues in the former Yugoslavia. Psacharapoulos and Ng (1994) show that in Latin America, primary education has the highest rate of return. In Mexico, secondary education is the most profitable (Psacharopoulos, 1996).

Besides saturation, another reason for the decline in these types of studies is simply that they seemed to have fallen out of fashion. Critics of the approach such as Blaug (1985) claim that the method is not valid because it focuses on the quantity of education rather than quality. Vocational educators are critical of the results of such studies mainly because post-secondary earnings are something over which they feel they have little control.

Of course, individuals are not the only ones who might gain benefits from education, and they are by no means the only investors in their education. Society makes a substantial contribution to education. For example, in the case of higher education in Oklahoma, 75 percent of the cost of a student's education is actually paid for through government appropriations – which translates into tax dollars.

Why should society be willing to make such an investment in individuals' education? The answer lies in public goods literature. Certain "goods" are considered to provide benefits to parties other than the initial consumer. Education, for example, is thought to provide various benefits to society as well as to the individual. Such a good is said to produce a positive externality or external benefit. This means that the marginal social benefit to be gained from the good is greater than the marginal private benefit received by the consumer. Since an individual makes consumption decisions based only on private returns, too few individuals will make the investment in the good from society's point of view. To induce more consumption, the purchase of the good is subsidized by society.

In terms of higher education, for instance, many argue that there are widespread external benefits to be gained from the educational system. These possible benefits range from lower community crime rates to better population health to a better system of democracy. In order to recognize the full benefit of such effects of education, society should actually be willing to subsidize the individuals' higher education. This is, in fact, what society is doing when taxpayers allow their tax dollars to be used in the funding of higher education.

Are there outcomes to be measured that are based on society's investment in education? Of course! A straightforward study of outcomes might question whether crime rates are lower in communities where a greater percentage of the population has a college degree. Haveman and Wolfe (1984) consider a wide range of benefits to be gained from higher education and actually attempt to put dollar values on the positive externalities associated with higher education.

The vocational education literature has its own definitions of educational outcomes. Two types of outcomes are defined in particular: labor market outcomes and learning outcomes. Corresponding to the personal investment outcomes, described by Cohn and Geske, are the labor market outcomes. These include job placement and earnings. In general, vocational educators object to the use of such indicators as the sole measurement of program effectiveness (Asche, 1990). One objection is that many other personal and economic factors beyond the control of the educational system can determine the employment outcomes of graduates. Also, if the system relies too heavily on such outcomes, the trend of accepting only those students who can be successfully placed may develop (Asche, 1990).

A second category of outcomes discussed in vocational education literature is learning outcomes. Vocational educators are much more comfortable with learning outcomes because they do have some control over what and how much students learn. A common method of measuring learning outcomes in vocational education is the occupational competency test. As discussed in previous sections, the ODVTE is currently administering occupational competency testing as a means of measuring student learning outcomes in compliance with the Carl D. Perkins Act. Detailed descriptions of these tests and procedures will be deferred until later sections.

Officially, how does the ODVTE characterize its outcomes? This information can be inferred from the "goals for the 1990s" presented in the ODVTE's *Strategic Plan*. These include:

1. Assist in preparing a world-class work force by incorporating into the vocational curriculum the skills needed for success in the workplace and for successful living.
2. Enhance the economic growth and development of the state by providing training and services to individuals, business, industry, labor, and government.
3. Provide vocational-technical education programs and services in an environment that will accommodate all students who may benefit from skill development and successful living skills.

In goal 3, the consumption outcome of education is evident. Goal 2 addresses the investment of society in education. Goal 1 addresses the individual investment in education as well as the learning outcome. Clearly, the ODVTE concerns itself with all the outcomes of education discussed above. Darcy (1980) conducted a study of vocational outcomes and developed a list of 15 "appropriate and feasible" key outcomes of vocational education. Included in his list are learning outcomes (occupational skills), investment outcomes (postschool earnings), and consumption outcomes (school experience satisfaction). For a complete listing of Darcy's results, see Table 3.1.

It seems appropriate to note here that not all economists agree upon the importance of all the above outcomes. Although economists have attributed the widely observed relationship between earnings and schooling to levels of "cognitive knowledge" gained from school (basic skills, vocational skills) which raise productivity (human capital approach), others, such as Blaug (1985, p. 18), believe that job performance does not depend on cognitive knowledge gained at school. Instead, it depends on certain personality traits that are rewarded in the classroom and so are "systematically encouraged by the educational system." For lower level jobs often filled by high school graduates, the relevant personality traits include punctuality, persistence, concentration, docility, compliance, ability to work with others, etc. For higher level jobs, often filled by university graduates, relevant traits are: self-esteem, self-reliance, versatility, capacity to assume leadership roles, etc. Blaug claims that employers do not care what workers know, only how they will behave. It is for this reason, according to Blaug, that vocational graduates are hired less than are academic graduates.

The above argument is called the screening hypothesis, and Blaug (1985, p. 21) argues that it has replaced the Human Capital Approach. He defines it as follows:

> ...educational credentials act as surrogates for qualities which employers regard as important, predicting a certain level of job performance without making any direct contribution to it.

TABLE 3.1

Educational Outcomes

	OUTCOME
1.	Basic Educational Skills
2.	Occupational Skills
3.	Reduced Unemployment
4.	Acquisition of World of Work Knowledge
5.	Effect on Educational Commitment
6.	Leadership Skills
7.	Post-secondary Educational Progress
8.	Post-school Earnings
9.	Satisfaction with School Experience
10.	Job-search Time
11.	Satisfaction with Graduates by Employers
12.	Attractiveness of the Community for Industrial Development
13.	Minority Employment Opportunities
14.	Job Placement in Training Related Fields
15.	Self-help Skills

Source: Darcy, Robert L. "Some Key Outcomes of Vocational Education." Research and Development Series No. 192 (The National Center for Research in Vocational Education: Ohio State University), 1980.

In simple language, a college degree, for example, serves as a "signal" to employers that a worker has the traits enumerated above. Consequently, college graduates are hired for high paying jobs over high school graduates, not because they are more productive, but because their degree signals employers that they will behave correctly on the job.

Educational attainment is not the only possible signal. In the past signals such as age, sex, race and marital status have been used in this way. Education and work experience are the most socially justifiable of the signals.

The screening hypothesis depends on attitudes developed by students through the educational process. While administrators at the ODVTE would likely agree that attitudes are an important outcome of the vocational system, they would hardly agree that their programs provide nothing more than a signal (whether positive or negative). The ODVTE is in "business" to provide vocational skills to potential workers, raise workers' productivity, provide benefits to the students, and contribute to the economic development of the state of Oklahoma (ODVTE, 1990).

Clearly, the question of educational outcomes is a complex and controversial one. Simply knowing the categories of outcomes for education is not enough. A researcher must choose the outcome on which to focus the research. Once chosen, the researcher must then decide upon the appropriate measure for that outcome. Many of the investment studies discussed above used post-schooling outcomes such as earnings. Hanushek (1986, p. 1151) says that the problem with using post-schooling outcomes is that they "cannot be contemporaneously observed with the schooling." Also such studies tend to focus on the quantity of education instead of quality. Remember that Blaug (1985) made the same complaint. For this reason, he claims, economists have been of less help than have sociologists and psychologists in improving the educational process.

A different approach to the measurement of outcomes would be to consider what attributes of schooling will be important for future success and then creating a measure that can be used during the same period as the schooling (Hanushek, 1986). These, of course, are the learning outcomes. Some examples of such outputs that ought to be considered according to Cohn and Geske (1990, p. 165) include:

1. Basic cognitive skills – Math skills and verbal skills have long been popularly studied outcomes. A number of tests have been created in order to measure these skills: The Comprehensive Test of Basic Skills, Iowa Tests of Educational Development, ACT, SAT, etc.
2. Creativity – Many schools attempt to foster creativity, and thus it should be studied.
3. Attitudes – Considered an important part of success, attitudes are clearly an outcome to be considered. Unfortunately, the proper "mix" of attitudes is not universally agreed upon, and they are difficult to measure as well. Even so, psychologists have measured certain types of attitudes (motivation, job satisfaction, etc.) and these might be useful for input-output analysis.
4. Vocational skills – According to Cohn and Geske, "...no systematic vocational tests of the type developed for basic skills have been used to assess the performance of vocational education...since vocational education is clearly an identifiable educational goal, its exclusion from a formal model of the educational process cannot be justified".

Cohn and Geske wrote this prior to 1990, which is, of course, the same time period during which vocational educators were beginning to develop the concept of occupational competency testing. Several years later, the use of such testing is still in its infancy. This, of course, explains the lack of studies relating acquired vocational skills to the inputs used in the vocational system.

For this study, the outcome to be analyzed is the learner outcome as characterized by vocational skills. For this purpose, the ODVTE has provided occupational competency scores – scores which measure the student's competency in the skills of his/her chosen occupation. Formally, the occupational competency tests scores will stand as a proxy for the measurement of the output of Oklahoma's vocational system.

Inputs to the Educational Process

Brown and Saks (1981, p. 223) define schooling as "a process in which student time and teacher time are combined with other resources to produce an output called learning." Educational psychologists try to understand and improve the learning curve (how can students be made to learn better). This is beyond the scope of the economist who simply assumes the learning curve to be a given. Instead, economists "ask how such curves relate to optimal private and social decision making and resource allocation."(Brown and Saks, 1981, p. 223) In other words, it is not the economist's job to tell a teacher *how* to teach. It is the economist's job to attempt to understand which combination of inputs is the most efficient in producing the desired output. How much should a school pay its teachers? How many books should be located in a classroom, etc.? Or, how will the outcome *change* if the number of books is increased or if teachers' salaries are increased?

Brown and Saks (1981) define 2 categories of inputs into educational outcomes.

1. Student background characteristics not subject to change such as race, sex, family income, aptitude, etc.
2. School choice variables such as class size, instructional methods, and classroom materials.

Perl (1973) adds a third category:

3. Background of other students at the school such as race composition, average family income, etc.

Consider first, school inputs. Cohn and Geske (1990) divide these inputs into human inputs and physical inputs. Physical inputs could include building or classroom dimensions, quantity and quality of equipment, instructional materials, etc. Sometimes, expenditures per pupil are used as a proxy for the physical inputs. This brings up an interesting paradox in the performance of schools. Expenditures per pupil have been rising yet test scores have remained low or even fallen. Both verbal and mathematics skills on the SAT fell from 1963-1980. SAT verbal scores fell by more than 11%, and math scores fell by more than 7%. Expenditures per pupil, on the other hand, rose by more than 135% in real terms over that same period.

Fisher (1988) offers some possible explanations for the paradox.

1. Beginning in the 1960s there was a change in the mix of the students who took these college entrance exams. Minorities and lower income students who would previously have not gone to college were encouraged to do so.
2. There was a shortage of qualified teachers in mathematics and science due to teacher education that focused on education classes over academic classes.

3. There was an introduction of broader, less academic curricula and new teaching methods.

Basically, it all comes down to the fact that we just do not know exactly which inputs are the most important and how they affect outcomes in education. This is why research continues.

The human inputs discussed by Cohn and Geske (1990) usually include administrators, counselors, teaching aides, and, of course, the teachers. Clearly, teachers are a crucial link in the educational process, and much effort has been devoted to determining their impact on outcomes. A popular proxy for the teacher input has often been teacher salary. Many have been surprised to find no significant effect of teacher salary on outcomes. Early researchers, such as Coleman, took this to mean that teachers did not affect learning. This was an incorrect conclusion. Clearly, teachers affect students. A better conclusion, according to Cohn and Geske (1990), is that the teacher salary measure is not a very good proxy for the teacher input. It may pick up years of experience and educational attainment, but it says nothing about the really important qualities of a teacher such as enthusiasm, dedication, resourcefulness, and creativity. Finding the appropriate proxy to use will probably remain a problem with incorporating the human inputs into the analysis.

Next, consider student background inputs. Family background inputs are usually measured by socio-demographic information such as parental education, income, and family size. Information about the student usually includes race, sex, and aptitude. It must be kept in mind that each student brings different levels of ability and aptitude into any classroom, and this must be taken into account in any study.

Finally, Perl (1973) notes that the background and characteristics of other students at a school may affect the outcome of a particular student. Brown and Saks (1981, p. 231) refer to this as the "peer group effect." This occurs when "the learning curve of a student shifts when the characteristics of students in his or her instructional group...change." This implies that outcomes can be improved by creating "good groupings" which maximize positive effects.

An obvious area of application for this type of analysis would be to the concept of "bussing." Should minority students be bussed to schools with primarily non-minority student-bodies? If the analysis shows that an even racial mix at a school improves outcomes, then the answer may be, "Yes." If racial mix has no affect on achievement, then the answer may be, "No."

Fisher (1988) says that there are three issues concerning inputs that must be resolved before the production function analysis can begin.

1. In education, inputs are expected to have a cumulative effect. For example, how well a student does in the 11th grade depends, to some extent, on how well he or she did in all previous grades. The researcher has two choices. He/she can either relate the score of a test for one particular grade to inputs for that grade plus inputs for all past education, or he/she can measure a gain in achievement for a particular school year and relate that to inputs for that year only.
2. School inputs can be measured by actual numbers, such as number of days in the school year, years of teacher experience, types of subjects taught, etc., or inputs can be measured by the amount of money spent on that input.

3. The unit of analysis must be decided upon. Should the focus be on one classroom, or on the school, or on the system?

All of this discussion about types of inputs and what inputs are appropriate may have made the reader curious about what inputs have been found to be important in affecting outcomes – usually test scores. If so, Hanushek's (1986) review paper is highly recommended, but a brief review of Hanushek's discoveries may be in order.

What kind of effect does the teacher have on test scores? Recall that the Coleman Report of 1966 seemed to indicate that it did not matter which teacher a student had. Subsequent studies have focused directly on this question (Hanushek, 1971, 1986; Murnane and Phillips, 1981; Armor et al., 1976). Hanushek(1986, p. 1159) calls the results "unequivocal." "Teachers and schools differ dramatically in their effectiveness." The problem has been that the measures of the teacher's impact have been "seriously flawed." Some of these measures include teacher's education, teacher's experience, and teacher's salary. None of these have shown significant importance in increasing test scores. The conclusion is that they are poor indicators of the true impacts of a teacher. The only teacher variables which seem to be important are those which distinguish between different levels of skill. A consistent finding is that teachers who perform better on verbal ability tests do better in the classroom (Hanushek, 1981). Armor et al. (1976) and Murnane (1975) both found that principals' evaluations of teachers were highly correlated with the achievement of students.

It continues to be argued that increased expenditures will improve outcomes in schools. What does the evidence show? Of 112 studies that analyzed class size, only 9 studies showed a significant impact. Of 65 studies that included expenditures per pupil, only 13 showed a positive impact. Hanushek (1986, p. 1162) calls the results consistent. "There appears to be no strong or systematic relationship between school expenditures and student performance."

Other consistent results seem to be that family background of the student is very important in explaining achievement. For instance, children with wealthier and more educated parents perform better in school.

Various other variables seem to have produced mixed or ambiguous results. These include characteristics of peers within schools, organizational aspects of schools, specific curricula, school facilities, and school administrators and personnel. (See Table 3.2 for a summary of Hanushek's findings.)

Clearly, there is no consensus among economists concerning the inputs that should be included in the educational production function. In addition, there are no results that guide the researcher investigating vocational education outcomes specifically. Consequently, this study must depend on the theoretical assumptions described above and the advice of vocational educators and administrators.

Wentling and Preskill (1984) conducted a survey of 952 vocational educators from the state of Illinois in an attempt to discover "quality features" of a vocational program. In total, 153 separate inputs were reported. A list of the top 15, ranked by importance, is presented in Table 3.3. Many of these "quality features" will, in fact, be represented in this study, including instructors, equipment/materials, facilities, support services, and student skill assessment.

TABLE 3.2

Hanushek's Summary of Expenditure Parameter Coefficients from 147 Studies of Educational Production Functions

Input	# of Studies	Statistically Significant		Statistically Insignificant
*	*	+	-	*
1. Teacher/Pupil Ratio	112	9	14	89
2. Teacher Education	106	6	5	95
3. Teacher Experience	109	33	7	69
4. Teacher Salary	60	9	1	50
5. Expenditures per Pupil	65	13	3	49

TABLE 3.3

15 Quality Features of a Vocational Program

RANK	FEATURE
1.	Instructors
2.	Instruction Methods
3.	Curriculum
4.	Equipment/Materials
5.	Program Management
6.	Student Skill Assessment
7.	Staff Development
8.	Facilities
9.	Course Sequence
10.	Career Plans
11.	Program Evaluation
12.	Placement Rate
13.	Support Services
14.	Articulation
15.	Community Involvement

Source: Wentling and Preskill (1984)

CHAPTER IV

METHODOLOGY

Performance-Based Occupational Tests

The purpose of this study is to develop a production function describing the relationship of various inputs to a desired output for vocational education in Oklahoma. As previously stated, the output of vocational education will be measured by the performance-based occupational test administered by the Oklahoma Department of Vocational and Technical Education. Until now, the mechanics of this test have been largely ignored. The following section will define and describe the occupational exam.

The performance-based tests are specifically designed to relate to industry validated occupational duty/task lists. The occupational tests are carefully compiled based on information gathered from industry representatives, vocational instructors, and state level vocational educators. This information is used to create a listing of specific occupations and the specific tasks and duties associated with each occupation. Occupational experts then write performance-based test questions that correspond to the duty/task lists.

Each series of tests measures three areas of learning: cognitive, affective, and psychomotor. To this end, each series contains sections of cognitive and hands-on components. The cognitive section contains multiple choice questions that relate to actual tasks to be performed in a specific occupation, and to situations that may arise in the occupational setting. The situational section contains "sets" of questions. Each set begins with the description of a scene, which may occur in the occupational setting. These "situational" cognitive questions are designed to test decision-making ability. The hands-on component of the test requires a student to meet the specific criteria of an assigned task, just as they would be expected to do in the work place, within a pre-determined time standard. The same committee which devises the duty/task lists determines how best to test each task. It may be decided that a given task is best tested through cognitive items, hands-on components, or a combination of the two.

Once a battery of questions for each occupational test has been established, the questions are stored in a test bank. Using random generation, representative test questions are selected for the tests. The specific number of questions in each section of an occupational test will vary from occupation to occupation. The ODVTE uses a statistical formula to determine the appropriate number of questions. Components of this formula include: size of the available test bank, number of tasks in the occupation, and number of duties required by the occupation. Studies have shown that these tests are a representative sample of the duties and tasks critical to specific occupations (ODVTE, Testing Center, 1990). The Oklahoma Department of Vocational and Technical Education began administering pilot competency tests in 1989. By 1990, duty/task lists were available for 32 vocational programs consisting of over 200 occupations. In January of 1993, the program was officially underway to ensure compliance with the legislative requirements of the Carl D. Perkins Act of 1990. To date, competency exams are not yet available for all occupations; however, the number of exams and the number of students served have swelled since 1993. The competency tests used by this study are the General Electronics

Technician, the Marketing Education-Manager Trainee and the Marketing Education-Salesperson test. Competency exams were given for several occupations in 1993-94; however, these three were chosen primarily because they yielded an adequate number of observations at that time.

Inputs to Vocational Education in Oklahoma

The purpose of this study is to show which inputs are effective in producing the above output (occupational test scores). The following section will present the variables to be used as inputs into the educational process. Theoretical justifications for the use of each variable will be discussed as well.

First consider the group of variables described as *student inputs*. For this study, these will include student grade level, sex of student, white or nonwhite, economic disadvantage, and academic disadvantage. These variables are all available from the ODVTE based on an annual survey of vocational students.

1. Adult/Student:

Oklahoma's system of vocational education is open to secondary students as well as to adults seeking to upgrade their job skills. It is quite possible, therefore, that high school students and adults may be taking the same occupational exam. The adult students may undertake academic pursuits with more seriousness than would a teenager. In addition, the adults may have already become familiar with certain job skills which will allow them out-perform secondary students on an occupational competency exam. The variable ADULT will be entered into the model as a dummy variable. A value of 1 will be assigned to adult students while secondary students will be assigned a value of zero. The expectation is that adults will score higher on the occupational exams; thus, the sign for the coefficient of ADULT should be positive.

2. Gender of Student:

Vocational students may enroll in any program where they have an interest; therefore, programs which may be viewed as typically male oriented, such as auto-mechanics and electronics, may very likely serve female students. Programs viewed as typically female oriented, such as cosmetology and childcare, may also serve male students. It is necessary, consequently, to distinguish between female and male students who are taking a particular occupational exam.

The occupational exams utilized by this study are those for General Electronics Technician, Marketing-Manager Trainee, and Marketing-Salesperson. If social stereotypes were adhered to (whether valid or not), it might be predicted that males would do better than females on the General Electronics Technician exam. If sex of student is entered as a dummy variable and females are assigned the value of 1, then the above prediction would produce a negative value for the coefficient of GENDER, at least for the General Electronics Technician scores.

With respect to the scores for Marketing-Salesperson, there is really no social or economic justification for expecting one group to do better than another. The prediction for the coefficient GENDER with regard to the Salesperson scores is considered to be indeterminate.

3. Race of Student:

The race of the student will be entered into the equation. Statistically, minority families tend to have lower incomes than do white families. Reasons for this may include social prejudice or lack of opportunities for education. Frankly, this question is a topic for study by itself. If minority students are from lower income families, then they may be at a disadvantage when taking the occupational exams. MINORITY is defined as a dummy variable, which is given the value of 1 if the student is considered to be a racial minority and a value of 0 if the student is not a racial minority. The coefficient of MINORITY is expected to have a negative sign.

4. Economic Disadvantage:

Teachers are asked to report if an individual student has an economic disadvantage. Their answers are based on a survey that is administered to the vocational students. The literature suggests that economically disadvantaged students or those from families with lower incomes do not perform as well on tests as do students from higher income families. Tuckman (1971, p. 492) claims that some backgrounds "encourage or supplement student learning." Perl (1973, p. 160) states that the relationship of family income to performance is "theoretically well grounded." High-income families can provide books, educational materials, and a place and time to study. Hanushek (1986, p. 1163) reports that "virtually regardless of how measured..." the children of wealthier parents do better on average. The variable ECON will be entered into the model. A value of 1 will be given to those students determined to have an economic disadvantage. Those with no disadvantage will be given a value of zero. Since it seems likely that economic disadvantages may explain lower scores, this variable's coefficient should have a negative sign.

5. Academic Disadvantage:

Vocational teachers are instructed to identify those students with academic disadvantages apart from low income. A student is labeled as academically disadvantaged if he or she operates at a grade level that is two or more years below their actual grade level. This variable is intended to capture the innate ability of the student. Cohn and Geske (1990, p. 162) refer to this as the "initial educational endowment of the student." Unfortunately there is no great availability of measures of initial endowment. Possibly IQ or aptitude scores would serve well in this capacity; unfortunately, these types of test scores are not readily available to most researchers. Luckily, the ODVTE does collect data relating to academic disadvantages. For this study, it is known that some students have less of an initial endowment (because of their academic disadvantage) than do others with no disadvantage. ACAD is defined as the dummy variable that indicates academic disadvantage. Those students who are found to have such a disadvantage will be assigned a value of 1. Students with no disadvantage will be assigned a value of zero. It seems obvious that those students with an academic disadvantage will not perform as well on the occupational test, and so a negative value is expected on the coefficient of ACAD.

Another category of inputs will be referred to as the *peer group effects*. Brown and Saks are convinced of the importance of peer group effects. The main idea is that one student's learning curve may shift when the characteristics of his or her learning group change. The roles of race and social class have been of particular interest probably because of their practical and social relevance. Hanushek (1986) finds the impact of such variables ambiguous. Link and Mulligan (1991) take a specific look at this question and find quite interesting results. One important result found by Link and Mulligan is that all students perform better on math and reading tests when their learning group is composed of high achievers. They also found that black students appear to be especially sensitive to the racial mix of their classmates – doing better when the percentage of black students in their class rises. Link and Mulligan claim this may be due to a less hostile environment of learning.

Mulligan (1984) explains the theoretical basis of the peer group effect. Students of lower ability will demand more of the instructor's attention. Other students will either have to wait for or be denied the teacher's assistance. Since there is some evidence to suggest that low-income students, who are often of minority status, do not perform as well on tests as do non-minority, upper income students, it seems reasonable to consider the impact of classroom racial mix and income mix on individual performance. Based on Mulligan's explanation, as the percentage of nonwhite students increases and the percentage of students who are economically disadvantaged increases, individual test scores should fall. It is also reasonable to expect that as the number of students with an academic disadvantage increases, test scores will fall.

6. PERNON:

PERNON indicates the percentage of students taking a particular occupational competency exam who are non-white. Because racial minorities tend to come from families with lower incomes, they may have a disadvantage when taking exams. This variable is expected to have a negative coefficient.

7. PERECO:

PERECO will indicate the percentage of the students taking a test who have an economic disadvantage. This coefficient should also be negative.

8. PERACA:

PERACA will provide the percentage of students taking a test who have an academic disadvantage, and the sign should be negative.

The next category of inputs to be considered is *school inputs*. Frankly, the most straight-forward method of measuring the impact of the school on a student's performance is to calculate the expenditures per student in relevant categories. This is probably one of the most controversial sets of inputs to be included in production function studies because many studies have shown no systematic relationship between school expenditures and student performance (refer to Table 3.2). Even so, Hanushek (1986) cautions against jumping to hasty conclusions. Incomplete information, poor data, and faulty research can all affect statistical results.

Considering the strong theoretical basis for believing that expenditures should, or at least could, affect student performance, any study would be remiss if it ignored the possibility. Given this, the following expenditures per pupil figures will be considered when possible.

9. <u>Cost Per Student for Guidance and Counseling</u>:

A student's performance in a particular occupational field surely depends on whether a student is predisposed to studying within that field and has the aptitude for it. As spending on guidance and counseling increases, a school should be better able to assess student aptitude and to assist students in their choice of program – giving them a better chance of success. Vocational educators list student skill assessment, course sequence, and career plans as three of the top 15 inputs for vocational education. All three might fall under the category of guidance and counseling. Thus as the variable GUIDANCE$ increases, test scores should increase – placing a positive sign on the coefficient of GUIDANCE$.

10. Cost Per Student for Instructional Support:

Here is the question that has haunted economists and educators since the publication of the Coleman Report. When schools spend more on teachers, equipment, and materials, do student scores improve?

The figure used in this study, cost per student for instructional support, may pick up at least two effects. For one thing, if schools spend more on instruction, this may mean that they hire *more* teachers. This lowers the student/teacher ratio. Common sense tells us that if teachers have to spread their talents among more students, the individual student get less attention, less support, and may do worse on exams. Lowering this ratio should improve student performance. Thus, as the cost per student for instructional support, INST$, increases, student scores are expected to increase.

A higher cost per student for instructional support might also reflect that a school pays each instructor more. Traditionally, higher salaried teachers are thought to be those with more experience or more education. Possibly, they may simply be perceived as "better" teachers – showing more skill, creativity, enthusiasm, etc. If this latter statement is true, schools which hire "better" teachers should produce "better" students. Both effects of higher spending point toward a positive relationship between expenditures on instructional support (INST$) and performance.

11. Cost Per Student on Administration:

Clearly, spending on administration (ADMIN$) is more indirect in its focus than spending on guidance and counseling and spending on instructional support. Even so, it will be included. It is possible that this variable may pick up certain effects. For instance, this variable may show that a school is better organized, with smoother channels for teacher/administrator cooperation. Such schools may be better at laying out long-term goals and accomplishing short-term ones as well. For these reasons, the variable ADMIN$ will be included and will be expected to have a positive sign.

In addition, *feeder school inputs* must be considered. Vocational education in Oklahoma has an interesting characteristic that must be accounted for in a production function study. Students at an area vocational-technical school (AVTS) only spend three hours of their day studying vocational skills. The remainder of the day is spent at a traditional high school. One AVTS may have a large number of high school districts which "feed" into it. These are referred to as feeder schools. It is very important to incorporate feeder schools into the analysis because not only do students spend one-half of their school day at the feeder school, but these 11th and 12th graders may have spent their first ten or eleven years of schooling in that school district as well.

How do these traditional schools rate? It makes sense that the better the feeder school, the more qualified the individual student will be to make decisions about his/her occupational field, to perform well in the vocational classroom, and to score high on the occupational exams. To get at this information, it might be appropriate to see how well students at the feeder schools perform on standardized tests. For instance, ACT scores are commonly used to measure students' preparedness for college.

12. ACT scores:

ACT scores are public record and could easily be used for the purpose of describing the feeder schools. Thus, an AVTS whose feeder schools post higher ACT scores may have students who have been well-prepared for college, and those AVTS should produce students who perform better on the occupational exam. The variable ACT will be entered as a weighted average of ACT scores from the various feeder schools of an AVTS. The "weight" is based on the population of the feeder school as a percentage of the total area school population. ACT should have a positive coefficient.

13. Stanford Tenth Grade Writing Scores:

The writing skills of feeder schools are simple to measure. The Tenth Grade Stanford Writing Test Scores are available for every school district in Oklahoma. Students and schools who have more sophisticated writing skills may have an advantage in developing vocational competencies because writing skill is associated with comprehension and analytical skills. The variable for this measure, WRIT, is predicted to have a positive sign. As writing scores improve, it is expected that students will do better on the occupational competency exam.

Finally, one last type of input must be addressed: *teacher inputs*. The buzz of controversy surrounding the question of impact of expenditures on student performance is surpassed only by the question of how teachers affect student performance. As stated in an earlier section, the Coleman Report left the impression that teachers and schools do not matter. Instead, the important factors were the ones beyond institutional control such as family background. As reported by Hanushek (see Table 3.2) many characteristics of teachers have been found to have little or no impact on student performance. These include teacher salary, teacher experience, and teacher education.

Despite these types of findings, it is simply ludicrous to believe that teachers have no impact on the performance of their students. Hanushek (1986) best explains the dilemma. These commonly used teacher characteristics are only proxies used by researchers as *indicators* of skill. Lack of statistical significance between these indicators and student performance really only demonstrates that these proxies are not good ones for measuring teacher skill. When other measures can be used, the results are more reassuring. For instance, Murnane (1975) was able to obtain principals' evaluations of teachers. Those teachers who were evaluated higher by their principals produced students with higher scores.

In order to understand why these traditional measurements of the teacher's impact in the classroom are inappropriate, each one should be briefly analyzed. First, consider the degree achieved by the teacher. It may be true, as generally argued, that the best teachers are the best because they have had more training and education. It may also be true that the teachers with the most desire to improve themselves by continuing their education are the ones with the most desire to see that their students do the same thing. It may also be true that teachers who are not satisfied with their own role as teacher will seek advanced degrees in order to advance their careers, possibly to the level of administration. With such conflicting motivations, it is no surprise that this type of variable shows inconsistent results in education production functions.

Next consider the experience level variable. Can it be assumed that teachers who have been teaching longer will be better teachers? Have such teachers gained so much from their experience that they can better manage their classrooms, better present necessary material, and better understand the needs of their students? May be. There is another side to this argument, however. One administrator said to me, "The best teachers have *energy*!" Teachers with more experience are necessarily the older teachers who may not have the energy level they once did. They may be bored with their jobs, lacking the excitement they might have had as new teachers. As with degree earned, this variable is so unpredictable in its motivations that no researcher should wonder at its lack of predictability.

Finally, a variable commonly used in production function studies is the teacher's salary. The argument for the inclusion of this variable is that schools that offer higher salaries will attract the better teachers. Also, it is assumed that the best teachers are rewarded for their hard work and receive higher salaries. Frankly, that is not how the "real world" operates. In general, the basis for salary increases includes level of education and experience. If it has already been accepted that education and experience are not good predictors of teacher skill, then no reason exists for the inclusion of teacher salary, a variable that is dependent on education and experience.

If these variables do not accurately describe the teacher's input into learning, what does? Unfortunately, the answer to this question is completely subjective. One administrator said, "It takes energy." Another said, "The best teachers get involved with their students. Now measure that!" Evertson and Harris (1992) report that the public believes the best teachers are effective at classroom management and discipline. Frankly, one hundred different sources would probably produce one hundred different answers.

This study certainly recognizes the subjective nature of the teacher input. Even so, the teacher input must be captured in some way. To this end, a unique variable has been created. Vocational students often participate in vocational student organizations (VSOs) which relate to their program. For example, electronics students participate in an organization referred to as VICA. Marketing students participate in DECA. The intensity of activity within the VSO is usually dependent upon the level of involvement by the program's teacher; therefore, the following conclusion might be reached. The most active, energetic, and involved teachers will be associated with the most active VSOs; consequently, students who are involved with an active VSO should be expected to score higher on occupational competency tests.

14. Vocational Student Organization (VSO) Activity Level:

To measure the activity level of the VSO, lists of winners from the state DECA and VICA contests held annually were obtained. The schools that posted the most wins were categorized as having active VSOs. For instance, at the 1993-94 DECA contest the number of winners range from zero per site to 18 per site. This variable DECA (or VICA, whichever applies) will be entered into the model. The value of DECA (VICA) will be the number of winners posted by the relevant school at the 1993-94 contests. The sign on the coefficient of DECA (VICA) is expected to be positive.

Estimation of the Model

If the output of vocational education is to be measured by occupational competency test scores and the inputs to the process are defined as above, the general form for this production function becomes:

$$O = f(B_i, P_i, S_i, F_i, T_i)$$

where O is the occupational test score; B_i is a vector of student background effects; P_i is a vector of peer group effects; S_i is a vector of school related inputs; F_i is a vector of feeder school related inputs; and T_i is a vector of teacher inputs.

TABLE 4.1

Predicted Signs

VARIABLE	DESCRIPTION	EXPECTED SIGN
ADULT	Student is an adult	+
MINORITY	Student is a racial minority	-
GENDER	Student is a female	?
ECON	Student has an economic disadvantage	-
ACAD	Student has an academic disadvantage	-
PERNON	Percent of test-takers who are a racial minority	-
PERECO	Percent of test-takers who are economically disadvantaged	-
PERACA	Percent of test-takers who are academically disadvantaged	-
INST$	Spending per student on instructional support	+
GUIDANCE$	Spending per student on guidance and counseling	+
ADMIN$	Spending per student for administration	+
ACT	Weighted ACT score from feeder schools	+
WRIT	Weighted Stanford Writing score from feeder schools	+
DECA(VICA)	Number of wins per school at state competition	+

Questions about how to specify the production function for education stem from two main issues. The first issue is the appropriateness of a linear function. Will a linear function accurately depict the production process? In general, the answer to this question is, "No." Usually, economists like production functions to conform to the "law of diminishing marginal returns" which, in lay terms, means that adding more of an input will increase output, but, at some point, each successive addition will increase output by less and less each time. In other words, the marginal productivity of the input will eventually decline.

This characteristic most definitely implies that the production function will be nonlinear in shape. Figure 4.1 plots a nonlinear production function for a single input and single output.

A popular mathematical form for a production function that exhibits the law of diminishing marginal returns is called the Cobb-Douglas production function, written as:

$$Y = a_0 X_1^{a1} X_2^{a2},$$

where the a_i are fixed parameters to be estimated statistically. If the Cobb-Douglas specification of the production function appears to be relevant, then why do researchers continue to use a linear approximation? Cohn and Geske (1990) claim that "a linear approximation would appear to provide reasonably good estimates of the true production coefficients." Refer to Figure 4.1, the nonlinear production function. Notice that the segment AB could reasonably be estimated by a linear function; however, a linear approximation of the segment AC would be seriously inaccurate. The conclusion is that if there is relatively low variability in the amount of the input used, then a linear specification of the model is acceptable. The researcher would have to keep in mind, however, that the conclusions drawn by such an analysis would be applicable only within the range of sample observations. In other words, extrapolations of the model far beyond actual observations would give seriously distorted answers. If the linear approximation is acceptable, it takes the form:

$$O = a_0+\Sigma i(b_iB_i)+\Sigma i(c_iP_i)+\Sigma i(d_iS_i)+\Sigma i(e_iF_i)+\Sigma i(f_iT_i) + v,$$

where a_0 is the intercept or constant term; v is the random error term; and the b, c, d, e, and f terms are the estimated coefficients which represent the marginal productivity's of the inputs.

Of course, such a specification is a very simple multiple regression analysis operationalized by ordinary least squares (OLS) regression. The nonlinear specification, based on the Cobb-Douglas production function, can be rewritten as:

$$\ln Y = \ln(a_o) + a_1\ln(X_1) + a_2\ln(X_2)$$

The corresponding educational production function is:

$$\ln O = A_o + \sum i(b_i\ln(B_i)) + \sum i(c_i\ln(P_i)) + \ldots + v.$$

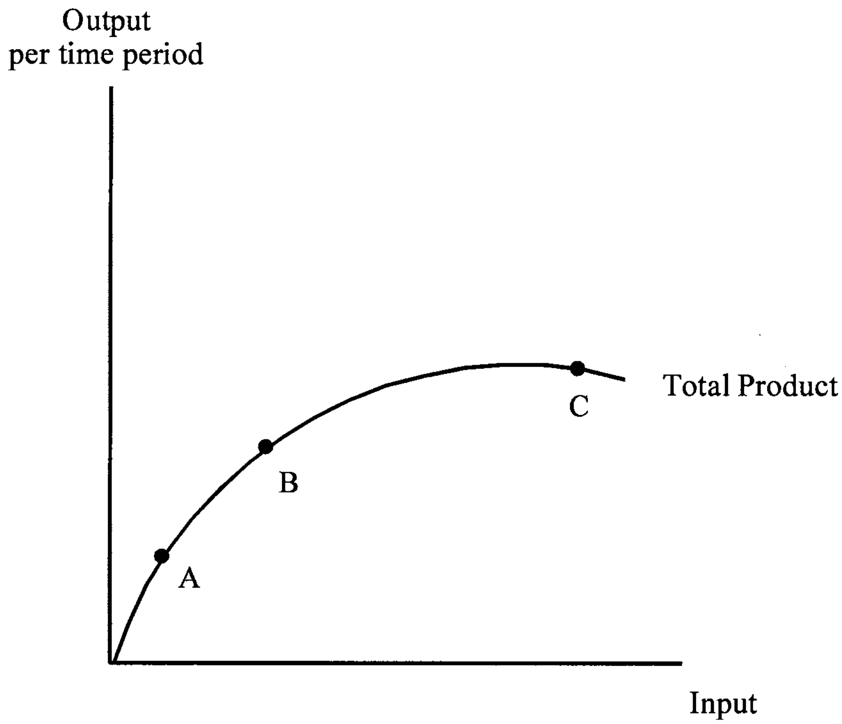
Only the linear specification of the model is estimated because this is a cross section of data from only one school year in which the variation was minimal. Preliminary executions indicated that no new or interesting information was provided through the nonlinear specification.

The second major issue concerning production function model specification is the argument concerning single output versus multiple output. The bottom line is how many outputs (qi) are there to education? If there are n outputs of education, and output q2 has some effect on output q1, then the two outputs are clearly not independent of each other. If inputs to q1 also impact q2, and q2 impacts q1, then the examination of an input's isolated effect on the output, q1, is biased. If there are n outputs that impact each other, then they should be considered as an independent system of simultaneous equations.

In simpler language, there might be two outputs of education, reading skills and math skills, and these two might be related to each other. For instance, scores on math tests might depend on the time allocated by teachers to math instruction and time allocated to reading instruction. Thus, reading scores and math scores are actually related, and the estimation of only math scores by a single equation least squares regression is extremely oversimplified and biased. Instead, the two equations should be estimated simultaneously.

FIGURE 4.1

The Nonlinear Production Function



Given the above discussion, it might seem unusual that most education production function studies utilize single equation models, but Hanushek (1979, p. 362) says the following. "There is a wide variety of circumstances where such issues are inconsequential." His example is a situation where the two outputs are independently produced such as reading ability and sex education. In such a case, a single equation estimation of reading skills is acceptable. In addition, there could be two outputs that are related, but one is emphasized a great deal more than the other. In this situation, the bias might be empirically insignificant.

In vocational education, it does not stretch the imagination to believe that there is a single output, or at least one output that is emphasized dramatically more than any other. Vocational students enroll in vocational programs in order to learn skills associated with a particular occupation so that they might acquire a job in that field after completion of the program. Thus, for this study, it will be assumed that any bias associated with a single equation specification is statistically insignificant.

In summary, this study will utilize a single equation specification for a linear version of the vocational production function. The dependent variable will be performance-based occupational competency test scores as provided by the Oklahoma Department of Vocational and Technical Education. The independent variables will be those discussed in previous sections from the following broad categories: student background inputs, peer group effects, school inputs, feeder school inputs, and teacher inputs.

CHAPTER V

RESULTS

Description of Data Sets

The Oklahoma Department of Vocational and Technical Education (ODVTE) provided several sets of occupational competency test scores. Within the Electronics program, 231 test scores from 17 area vocational-technical schools (AVTS) were available for the General Electronics Technician exam. Scores were for both secondary and post-secondary students. Within the Marketing Education division, 864 scores from 42 sites were available for the Salesperson test. Test sites included both AVTS and comprehensive high schools. This poses some problems for model specification. In addition, 101 scores were available for the Manager Trainee occupational exam. These also originated from both AVTS and comprehensive high schools. Most of the Marketing Education test-takers were secondary high school students. For a more detailed description of the data sets, refer to Appendixes A and B.

For a full understanding of the two Marketing Education data sets, the program must be further explained. The marketing curriculum essentially requires two years to complete. During the first year of study, the focus is sales. At the end of the first year, all students should be qualified to take the Salesperson occupational competency exam. The focus of study during the second year of the program is manager training. After completion of the program, a student is qualified to take both the Salesperson and the Manager Trainee occupational competency exams.

If the student enrolls in the Marketing Education program at a comprehensive high school, they are in the classroom for one hour a day. Also, they co-op during the afternoon, but only during the second year. "Co-op" simply means that the student works part-time and receives school credit for doing so. However, if the student enrolls in the program at an AVTS, the student will co-op for both years.

The students who take the Salesperson exam learn under essentially the same conditions as do their schoolmates who take the Manager exam. They share the same classrooms, are instructed by the same teachers, and have the same equipment available to them. For this reason, I considered grouping the two data sets together into one large set with 965 observations. Of course, the distinction between tests would have to be made by utilizing a dummy variable.

This will not be done. The major reason for making this decision was because the conditions faced by the separate sets of students are not *exactly* the same. The students who take the Manager exam have been exposed to more advanced curriculum, have been in the particular classroom setting for an extra year, and may have worked in the market place for an additional year. This is probably enough of a reason not to group the two sets together; furthermore, initial tests of such a specification did not yield any additional interesting information. Because the two data sets will not be grouped together, this leaves the number of observations from the Manager Trainee exam at 101.

The three data sets will be treated in a parallel manner. First, a specification will test the model using student characteristics (MINORITY, ADULT, etc.) as well as dummy variables that indicate the specific school or site of the program. This will show whether there is any reason to suspect that the program sites do have different impacts on test scores (the dependent variable).

Next, the dummy variables will be dropped, and, in their place, various school characteristics (ADMIN$, ACT, VICA, etc.) will be added to the specification to see if these variables might affect test scores. Finally, the program sites that perform the best on the competency exam and those that perform the worst will be compared by examining some of the values of the schools' characteristics like mean ACT scores or spending per FTE on guidance and counseling, etc.

Results from General Electronics

The General Electronics Technician occupational exam yielded 231 observations from 17 separate sites at area vocational-technical schools. No scores were reported from the comprehensive high schools.

The first specification that was tested was one that included the student characteristics as independent variables. Also included as independent variables, were program site dummy variables that indicated from which particular site the test score was generated.

When utilizing dummy variables, it is necessary to omit one dummy from the specification in order to avoid perfect multicollinearity. The intercept term, or constant term, represents the average test score at the omitted school. The coefficients on the included school dummy variables represent the difference between the mean score at the dummy school and the mean score at the omitted school. Thus, a coefficient of 30.00

represents a school that, on average, scored 30 points higher on the occupational competency test than did the omitted school. If no schools emerge with significant coefficients, this would indicate that it does not matter which school a student attends the program.

Clearly, from Table 5.1 some school programs do produce higher test scores than others. Seven schools emerged with significant coefficients. Three of those seven AVTS had positive coefficients. For instance, AVTS6 had the most profoundly positive effect, and scored, on average 23 points higher than the omitted school. AVTS 16 had the most negative effect, and scored 16 points lower than the omitted school.

TABLE 5.1

General Electronics
Test of Site

VARIABLES	COEFFICIENT	T-STAT
C	63.034	42.718**
ADULT	7.291	4.337**
ECON	-0.145	-0.241
ACAD	-6.582	-3.420**
GENDER	-0.382	-0.184
MINORITY	-2.870	-1.446
AVTS1	5.549	2.220**
AVTS2	3.127	0.778
AVTS3	0.162	0.056
AVTS4	-8.111	-3.004**
AVTS5	-4.138	-1.759*
AVTS6	22.911	6.535**
AVTS7	-14.996	-2.618**
AVTS8	4.468	1.150
AVTS9	-1.438	-0.327
AVTS10	-2.181	-0.721
AVTS11	-1.747	-0.494
AVTS12	6.649	2.034**
AVTS13	1.136	0.361
AVTS14	6.379	0.923
AVTS15	11.671	1.229
AVTS16	-16.056	-2.356**

** Significant at the 5% level.
* Significant at the 10% level.
Adjusted R-Squared = 0.27

Since different schools *do* have different effects on test scores, it now becomes important to question if the traditional methods of measuring the impact of the school by including certain school characteristics in the specification will explain these differences. Table 5.2 contains the results of such a specification.

The results from this linear specification that contains both student and school characteristics as independent variables were generally as predicted. For instance, the prediction that adult students would do better on the occupational exam was justified. Also, as expected, students with an academic disadvantage did worse on the test, and students from schools with higher spending on guidance and counseling did better.

Test groups with higher percentages of non-white students and academically disadvantaged students produced lower test scores. Schools with active VICA clubs produced better scores as well. Briefly, those variables which were significant at the 5% level and were of the predicted sign are as follows: VICA(+), ADULT(+), ACAD(-), GUIDANCE$(+), PERNON(-), and PERACA(-). Of these, VICA, GUIDANCE$, PERNON, and PERACA are school descriptors.

Generally, it is to be expected that a few chosen variables will prove to be insignificant. In this regression, the gender of the student had no impact on test scores; therefore, males and females can be expected to do equally well on the General Electronics Technician exam. In addition, the race of the student did not influence the test scores. ECON also did not show significance. As expected, the sign of ECON was negative, but this has no apparent effect on test scores. Finally, WRIT and ACT were also not found to have any impact on test scores.

The remaining results may require a bit more discussion. One interesting variable is INST$, cost per student for instructional support. Remember, this variable accounts for spending on teachers which should capture such effects as teacher salary and the pupils per teacher ratio. The coefficient of INST$ was found to be significant; however, the sign assigned to INST$ was negative instead of the predicted positive value.

TABLE 5.2

General Electronics
Student and School Characteristics

VARIABLES	COEFFICIENT	T-STAT
C	81.796	2.037**
ADULT	7.501	4.596**
ECON	-0.894	-0.485
ACAD	-6.138	-2.970**
GENDER	-0.265	-0.119
MINORITY	-2.911	-1.415
ACT	0.839	0.411
GUIDANCE$	0.024	3.070**
INST$	-0.025	-4.542**
ADMIN$	-0.082	-4.694**
PERNON	-0.707	-4.452**
PERECO	0.230	4.040**
PERACA	-0.462	-4.587**
WRIT	-0.107	-0.464
VICA	0.074	2.753**

** Significant at the 5% level.
* Significant at the 10% level.
Adjusted R-Squared = 0.23

This result simply reinforces the findings throughout the educational production function literature, which show traditional measurements of the teacher's contribution to education to be lacking in predictive powers. Another variable that measures the dollar input into education is ADMIN$. This variable measures the cost per student for general administration. Significance for ADMIN$ did exist at the 5% level; however, its sign was not as predicted. The prediction was that schools which spend more for general administration may be better organized, have better channels of communication, and be better at short term, as well as long term goal setting. This might produce an environment conducive to better learning; therefore, test scores should increase.

In fact, schools that spend more on general administration are associated with lower test scores. One might wonder if such schools are putting too much emphasis on administrative matters including bureaucratic paperwork, meetings meant to produce long-term goals, discussions on "quality management," etc. It should be noted that these inferences are purely speculation; even so, it makes this author wonder if such schools should be focusing their attention and dollars more directly at the students? The positive and significant coefficient on GUIDANCE$, cost per student for guidance and counseling, lends even more credence to such a speculation.

Another variable whose sign was shown to be opposite to the sign predicted is PERECO, the percent of the test group that is economically disadvantaged. Given the result that economic disadvantage, ECON, apparently has no impact on a student's ability to score well on the competency exam, it frankly might be expected that PERECO should also prove to be insignificant. This was not the case. PERECO was, in fact, significant at the 5% level, but it had a positive coefficient. This means that as the percentage of students with an economic disadvantage within a test group rises, the school actually posts higher scores on the competency tests. Further discussion of this phenomenon will be deferred until a later section. To summarize, the various program sites do, in fact, vary in the production of test scores. The following school descriptors appear to have some value in explaining those differences. Guidance dollars may increase scores. Dollars to administrative and instructional support may decrease test scores. A higher percentage of minority students and academically disadvantaged students within the test group may decrease scores; however, a higher percentage of economically disadvantaged students within the test group may actually increase scores. Finally, program sites with active chapters of VICA will also produce higher test scores.

Since some program sites do seem to perform better than others, one might naturally wonder what the best schools have in common. To address this kind of question, refer to Table 5.3. This table presents some of the school characteristics and compares them across sites. The site rankings are based on the results of Table 5.1.

Instead of providing the actual value of a variable for a site, an index was created in order to help maintain the anonymity of the various sites. For example, an index of 1.000 is equal to the mean value of the variable for all test-taking sites. An index of 1.250 indicates that the site is 25% above the average. An index of 0.750 represents a site that is 25% below average.

Notice first the index for SCORE. As expected, the top ranking AVTS do, in fact, have the highest mean scores. All are above the average. Accordingly, the four lowest ranked AVTS have the lowest mean scores. All are below the average.

The variable GUIDANCE$ indicates the spending per student for guidance and counseling at each school. The regression from Table 5.2 indicated that GUIDANCE$ has a significant, positive effect on test scores. It is not surprising, then, that the top-ranked AVTS spends more than twice the average level on guidance and counseling per student. The second and third ranked AVTS, however, claim no budget for guidance and counseling. This is most likely due to dissimilarities in reporting procedures at the various schools. As anticipated, the four low-ranking AVTS have below average spending levels on guidance and counseling.

The variable ADMIN$ (cost per student for administration) shows no particular tendencies with respect to the top three and the bottom four sites. Similarly, WRIT (Stanford Writing score of the feeder schools) does not present a recognizable pattern. Most indices hover on or around the average.

Next consider the index for PERACA (percent of test group with an academic disadvantage). The regression in Table 5.2 indicated that as schools have a greater percentage of academically disadvantaged students, test scores fall; thus the high ranking AVTS should have an index for PERACA which is below the average. The first and second-ranked schools do indeed have this result, but the third-ranked school has twice as many academically disadvantaged students as the average. Of the four low ranking schools, only AVTS16, the lowest ranking AVTS, has a high number of academically disadvantaged students.

The variable PERECO was shown to actually produce positive results. In other words, those schools with a large number of economically disadvantaged students tended to do better on the competency test. The index for PERECO essentially supports this finding.

The variable PERNON (percent of test group that is non-white) had a significantly negative impact in the linear regression. The seven schools represented in Table 5.2 do not appear to depict the relationship.

Finally, the ACT indices hover around the average for all seven sites. This is as expected considering that the linear regression showed no relationship between ACT scores and competency test scores. Essentially, this comparison of variables across sites appears to confirm the findings of earlier regressions.

TABLE 5.3

Characteristics of Significant AVTS
General Electronics

RANK	AVTS CODE	Index SCORE	Index GUID	Index ADMIN	Index INST	Index WRIT	Index ACT	Index %ACA	Index %ECO	Index %NON
Mean		1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.	AVTS6	1.302	2.634	1.220	0.259	0.977	1.021	0.610	1.564	0.000
2.	AVTS12	1.065	0.000	0.780	0.726	0.889	1.027	0.417	1.681	0.568
3.	AVTS1	1.022	0.000	0.226	0.677	0.914	0.942	1.990	2.502	1.070
13.	AVTS5	0.921	0.714	1.694	0.822	1.030	0.962	0.353	0.625	0.000
14.	AVTS4	0.900	0.442	0.524	0.700	0.887	0.987	0.770	0.821	0.910
15.	AVTS7	0.849	0.025	2.243	0.000	0.965	0.999	0.193	0.156	0.000
16.	AVTS16	0.667	0.753	0.425	0.415	1.124	0.977	2.151	1.837	0.000

In order to test statistically for the existence of patterns like the ones examined in Table 5.3, an additional test was executed. The following school characteristics were used as independent variables: VICA, PERACA, PERECO, PERNON, ADMIN$, INST$, and

GUIDANCE$. These variables were used to explain the variation in the coefficients of the specific program sites in Table 5.1. These results are found in Table 5.4. No significant relationships are discovered.

When each variable was tested alone,(for example GUIDANCE$ is the only independent variable explaining school site coefficients) only three variables were significant enough (20-32% significance levels) to create positive adjusted R-squares. Those variables were PERACA, INST$, and GUIDANCE$. See Table 5.5. When these three variables were included in one regression, the resulting adjusted R-squared equaled 0.114 and INST$ was significant at the 10% level (10.4% to be exact). See Table 5.6. The positive sign on INST$ indicates that increasing funding for instructional support may improve the performance of students at a particular site. This contrasts with the variable coefficient in Table 5.2 and is the expected result.

TABLE 5.4

Test for Patterns Among Site-Specific Independent Variables
Dependent Variable: Coefficient of the Specific Site

VARIABLE	COEFFICIENT	T-STAT
C	-7.222	-0.553
GUIDANCE$	0.019	0.816
INST$	0.013	1.099
ADMIN$	-0.003	-0.103
PERNON	0.032	0.108
PERECO	-0.061	-0.414
PERACA	0.174	0.714
VICA	0.075	0.043
Adjusted R-Squared = -0.299		

TABLE 5.5

Three Separate Tests for PERACA, INST$ and GUIDANCE$
Dependent Variable in All Cases:
Coefficient of the Specific Site

VARIABLE	COEFFICIENT	T-STAT	ADJUSTED R-SQUARED
C	-1.117	-0.367	
PERACA	1.031	1.031	
			0.004
C	-3.914	-0.919	
INST$	0.011	1.334	
			0.049
C	-1.201	-0.405	
GUIDANCE$	0.020	1.445	
			0.020

TABLE 5.6

Independent Variables: PERACA, INST$, and GUIDANCE$
Dependent Variable: Coefficient of the Specific Site

VARIABLE	COEFFICIENT	T-STAT
C	-9.066	-1.785
PERACA	0.142	0.903
INST$	0.014	1.759*
GUIDANCE$	0.018	0.355

*Significant at the10.4% level.
Adjusted R-Squared = .114

Results from Marketing Education: Manager Trainee

The Manager Trainee occupational competency exam yielded 101 scores from 13 sites, both area vo-tech schools and comprehensive high schools. This causes a complication stemming from the fact that the Oklahoma State Department of Vocational and Technical Education and the Oklahoma State Department of Education (OSDE) do not collect the same statistics.

The ODVTE publishes an annual cost report which disaggregates spending according to numerous categories including: general administration, instructional support, transportation, guidance and counseling, etc. The OSDE does not do this. Instead, they produce a cost report that identifies total revenues for a school district. Since total revenue will often nearly equal total spending, and since total enrollment figures are easily available, a cost per student figure can be calculated for the comprehensive high schools. This variable was created and is called COST$. Cost-per-student figures are easily obtained for the area vo-techs from the annual cost report. The hypothesis is that COST$ will have a positive coefficient. As spending increases, scores are expected to rise.

In addition to the above-stated problem, the variable AVTS must be added to the specification. Since conditions are different at the area vo-tech schools compared to the comprehensive high schools, this difference must be controlled. For instance, area schools require the Marketing Education students to co-op for two years, while the high schools require only one year of co-op activity. The variable AVTS will be created. The variable will take the value of 1 if the score originates from an area vo-tech school and will take the value of 0 if the score comes from a high school. A positive sign indicates that the area vo-tech schools produce higher test scores. A negative sign indicates that the high schools do better.

After making these changes, the linear regression with Manager Trainee scores as the dependent variable and student characteristics along with school dummies as independent variables was performed. Results are in Table 5.7.

Recall that this data set contains scores from both area vocational schools (AVTS) and public comprehensive high schools (PHS). Referring to Table 5.7, note that all of the significant sites actually have negative coefficients. The only sites with positive coefficients could not be proven to be significantly different from zero. Thus, keep in mind that none of the sites performed better on the competency exam than did the omitted dummy school. However, AVTS1, which had the smallest significant difference in scores (10 points) from the omitted school performed better on the exam than did PHS2, which had the largest significant difference (40 points).

The next regression of this data is found in Table 5.8. The independent variables for this specification include the student and school characteristics, but do not include the school dummy variables.

Briefly, each variable in this linear equation will be evaluated. The variable ECON (indicates if a student has an economic disadvantage) was shown to be insignificant. So far, none of the regressions have shown ECON to be a predictor of test scores. It may be that ECON, as defined by this study, is not a good measurement of the student's economic background. Another explanation may exist.

Many studies have found that a student's economic background does have a significant impact on his/her academic outcomes, but consider the following speculation. Vocational students are often viewed as those students who do not excel at academic pursuits. Most are not college bound and are, therefore, training for a vocation that they might enter directly upon high school graduation. It may be that higher income students do better at academics because they are encouraged by a more academic atmosphere in their homes, but do higher income families usually encourage their children to focus on vocational skills? Probably not. Often, higher income families are more concerned that their children receive a college education. On the other hand, lower income families often cannot afford to send their children to college and may actually encourage vocational skills over college preparation.

Table 5.7

Marketing Education: Manager Trainee
Test of Site

VARIABLE	COEFFICIENT	T-STAT
C	-3.319	-0.063
ADULT	7.207	1.652*
ECON	-3.913	0.747
ACAD	-14.501	-3.358**
GENDER	2.999	1.203
MINORITY	5.048	1.475
AVTS1	-10.751	-2.241**
PHS2	-40.834	-8.227**
PHS3	-14.911	-3.065**
AVTS4	-28.576	-5.706**
PHS5	-23.161	-1.943*
AVTS6	12.253	0.975
PHS7	-29.661	-5.038**
PHS8	-5.210	-0.423
PHS9	-22.258	-4.170**
PHS10	-3.439	-0.666
PHS11	-28.304	-5.174**
PHS12	-29.828	-4.008**

** Significant at the 5% level.
* Significant at the 10% level.
Adjusted R-squared = 0.54692

Thus, the argument has just been made that ECON could actually have a positive sign when the output under consideration is vocational skills. With such offsetting motivations, this possibility may be at the heart of the explanation for why ECON shows no statistical significance.

The next variable, ACAD (indicates if the student has an academic disadvantage), was found to be negative and significant at the 5% level. So far this is a common thread in the results. It simply makes sense that a student with academic disadvantages will be outperformed on tests by other, non-disadvantaged students.

The variable ADULT just barely missed being significant at the 10% level. The positive sign on the coefficient *might* indicate that seniors taking this test could perform better than juniors. Unlike the General Electronics population, this group of test-takers was mainly secondary high school students – only a very few were classified as adults; consequently, it is not really odd to see this variable lose its significance. There is not a lot of difference in the maturity level of high school juniors versus seniors. (To account for the different data characteristics, ADULT is no longer a dummy variable valued at 1 for adults. Instead, ADULT is considered the grade level of the test taker – valued at 11 for juniors, 12 for seniors, and 13 for adults.)

TABLE 5.8

Manager Trainee
Student and School Characteristics

VARIABLE	COEFFICIENT	T-STAT
C	92.849	0.780
ADULT	8.059	1.551
ECON	-2.405	-0.382
ACAD	-14.110	-2.850**
GENDER	2.184	0.743
MINORITY	-0.627	-0.164
ACT	-9.178	-1.974*
COST$	0.006	0.717
PERACA	-0.091	-0.449
PERECO	0.148	0.675
PERNON	-0.222	-4.592**
AVTS	-8.459	-1.019
WRIT	0.856	2.041**
DECA	0.300	0.118

** Significant at the 5% level.
* Significant at the 10% level.
Adjusted R-Squared = 0.34

Again, GENDER and MINORITY showed absolutely no statistical significance. Speaking socially and normatively, this is actually quite a nice result to discover. How well you do on the Manager Trainee occupational competency exam does not depend on your gender or your race.

The variable DECA was not found to be significant in this linear regression. It was, however, positive, as expected. Remember that DECA was created to be a nontraditional measure of the teacher's input into the educational process. If it works as intended, DECA may show that the more active teachers, teachers who sponsor an active DECA chapter, will produce students who do better on the occupational exams.

The variable PERNON, the percent of students taking the occupational exam who are minorities, exhibited substantial statistical significance. General Electronics and Manager Trainee have both indicated that as the percentage of nonwhite students within the test group increases, test scores fall. This was the predicted result for this variable; nonetheless, the result must surely be disappointing for educators. It is also somewhat confusing considering that the coefficients on MINORITY appear to have no statistical importance.

The variable COST$ (per student pending) did not show statistical significance at either the 5% or 10% level with the Manager Trainee data set. The evidence is pointing to the possibility that additional dollars to education lead to zero marginal returns.

The ACT variable indicated statistical significance at the 10% level, and its sign was *negative*. With this set of data, it appears that schools with low mean ACT scores (and students who may not be well prepared for college) will likely do better on vocational exams.

Actually, this may make some sense. Several comprehensive high schools are well known for emphasizing vocational skills over college-prep skills. If this is the case, such schools could be predicted to produce students who perform well on vocational exams but not quite so well on the ACT, which does not measure vocational skills.

The variable WRIT performs nicely with this data set, exhibiting a positive correlation that was significant at the 5% level. Students with better writing skills appear to have an advantage in developing vocational competencies.

The variable AVTS did not produce any significant impact on the outcomes of scores. This indicates that it does not matter whether a vocational student takes the course at an AVTS or at a comprehensive high school. Finally, the remaining two variables, PERACA and PERECO failed to achieve statistical significance with this data set.

Because some program sites do perform better than others on the competency tests, certain variables that describe the school will be compared across sites. These comparisons are found in Table 5.9. As expected, the schools that ranked the highest have higher average test scores. No relationship presents itself for the COST$ index or for the ACT index. The DECA index shows some tendency for active DECA clubs to rank higher. The amazing result, however, from this information relates to the WRIT index. Notice how the WRIT (Stanford Writing score of the feeder schools) index drops with school ranking.

In addition to the familiar variables, a few other questions were analyzed where data was available. The entry NA indicates that this information could not be located for the AVTS.

The most interesting of these are the indices for teacher experience, teacher salary, and teacher educational attainment. These traditional teacher variables usually are found to have no impact on test scores. Notice that the teacher salary indices hover around average with no noticeable pattern. Similarly, the two remaining indices, experience and educational attainment, indicate that all the schools in question are higher than the state average. Which supports the common finding that these two factors do not affect test scores.

TABLE 5.9

Summary of School Characteristics
Marketing Education: Manager Trainee

RANK†	AVTS CODE	Index SCORE	Index COST	Index DECA	Index ACT	Index WRIT	Index %NON	Index AVG. SALARY
Mean		1.000	1.000	1.000	1.000	1.000	1.000	1.000
4.	AVTS1	1.144	0.964	0.637	0.982	1.200	0.352	NA
5.	PHS3	1.057	1.104	2.760	1.093	1.130	0.000	1.106
6.	PHS9	1.022	1.072	1.911	1.019	1.194	3.219	1.149
7.	PHS5	0.921	0.840	0.000	1.009	0.980	0.000	0.993
8.	PHS11	0.900	0.988	1.274	0.770	0.980	1.674	1.155
9.	AVTS4	0.891	1.080	0.849	1.024	0.942	1.189	NA
10.	PHS7	0.891	0.929	0.212	0.994	0.810	0.000	1.073
11.	PHS12	0.849	0.995	0.425	0.994	0.725	0.000	1.035
12.	PHS2	0.667	0.833	0.000	0.960	0.703	1.322	1.041

TABLE 5.9
(Continued)

RANK†	AVTS CODE	Index ADV. DEGREE	Index TEACHER EXP.	* Percent H.S.GRADS in COUNTY	* Percent VOTER REG. in COUNTY
Mean		1.000	1.000		
4.	AVTS1	NA	NA	NA	NA
5.	PHS3	1.047	1.026	0.97%	71%
6.	PHS9	1.349	1.098	0.82%	79%
7.	PHS5	1.809	1.094	1.21%	69%
8.	PHS11	1.069	1.145	1.04%	51%
9.	AVTS4	NA	NA	NA	NA
10.	PHS7	1.359	1.265	1.17%	78%
11.	PHS12	1.974	1.197	1.14%	72%
12.	PHS2	1.103	1.077	0.62%	69%

† Rankings are based on the results of Table 5.7.
* Index is not used. Entry is the actual percentage of the county with the appropriate characteristic.

In order to test statistically for the existence of patterns like the ones examined in Table 5.9, an additional test was executed. The following school characteristics were used as independent variables: AVTS, DECA, PERNON, PERACA, PERECO, and COST$. These variables were used to explain the variation in the coefficients assigned to the specific school sites in Table 5.7. Once again, this type of test failed to uncover any statistically significant relationships. Refer to Table 5.10

When each variable was tested alone, (for example COST$ is the only independent variable explaining school site coefficients) two variables were significant enough to create positive adjusted R-squares. Those variables were PERACA (significant at the 5% level and positive) and PERECO (significant at the 5% level and positive). See Table 5.11. When these variables were included in a single regression, the resulting adjusted R-squared equaled 0.234, but neither variable showed statistical significance, suggesting collinearity between the independent variables. Refer to Table 5.12.

TABLE 5.10

Test for Patterns Among Site-Specific Independent Variables
Dependent Variable: Coefficient of the Specific Site

VARIABLE	COEFFICIENT	T-STAT
C	55.142	0.564
AVTS	11.723	0.764
COST$	-0.017	-0.819
PERNON	0.104	0.617
PERACA	-0.159	-0.222
PERECO	0.426	0.573
DECA	2.053	0.806
Adjusted R-Squared = -0.166		

TABLE 5.11

Two Separate Tests for PERACA and PERECO
Dependent Variable in Both Cases:
Coefficient of the Specific Site

VARIABLE	COEFFICIENT	T-STAT	Adjusted R-Squared
C	-22.920	-5.674	
PERACA	0.307	2.309**	
			0.285
C	-21.858	-5.798	
PERECO	0.316	2.442**	
			0.311

** Significant at the 5% level.

TABLE 5.12

Independent Variables: PERACA and PERECO
Dependent Variable: Coefficient of the Specific Site

VARIABLE	COEFFICIENT	T-STAT
C	-21.937	-4.872
PERACA	0.019	0.037
PERECO	0.298	0.586

Adjusted R-Squared = 0.234

Results from Marketing Education: Salesperson

In terms of number of observations, the Salesperson test is the most impressive. This exam yielded 864 observations from both AVTS and comprehensive high schools: A total of 119 scores originated from AVTS and the remaining 745 scores originated from high schools. Since scores come from both types of schools, the same problems exist as described earlier with respect to the Manager Trainee occupational exam. The only cost variable available is per student cost, COST$, and the variable AVTS must be added to distinguish between the two types of schools.

The first regression involving this data set includes as independent variables both student characteristics and school dummy variables. Salesperson test scores originated from 42 separate sites. Of those, 12 are AVTS and 30 are comprehensive high schools (PHS). These results are reported in Table 5.13.

Of the 42 separate sites, 41 were placed in the equation as dummy variables. One site dummy had to be withheld from the specification in order to prevent multicollinearity. The intercept or constant term represents the average test score at the withheld site. Of those 41 sites, 29 were statistically significant. Of those 29, 28 performed better than the eliminated site and one site performed worse. The site with the negative coefficient was a public comprehensive high school. Of the remaining 28 sites, 22 were PHS and 6 were AVTS.

TABLE 5.13

Salesperson
Test of Site

VARIABLE	COEFFICIENT	T-STAT
C	73.141	9.952**
ADULT	-0.447	-0.721
ECON	-3.162	-2.690**
ACAD	-8.345	-6.931**
GENDER	0.033	0.159
MINORITY	-1.894	-1.707*
PHS1	5.789	2.028**
PHS2	-2.315	-1.002
AVTS3	-7.945	-0.991
PHS4	7.347	3.233**
PHS5	-0.590	-0.233
AVTS6	7.834	0.715
PHS7	12.756	6.476**
AVTS8	12.961	4.152**
PHS9	13.681	6.613**
PHS10	18.618	8.430**
PHS11	10.047	0.885
PHS12	23.014	3.496**
PHS13	5.457	1.230
PHS14	12.684	5.867**
AVTS15	-3.254	-0.291
AVTS16	7.956	2.616**
AVTS17	11.296	2.873**
PHS18	5.461	1.942*
PHS19	8.639	3.371**
PHS20	6.134	2.682**
AVTS21	22.780	2.036**
PHS22	35.432	3.146**
PHS23	12.084	4.033**
PHS24	4.904	1.808*
PHS25	15.500	5.921**
AVTS26	5.746	0.514
PHS27	-3.592	-0.447
PHS28	10.124	3.450**

TABLE 5.13
(Continued)

VARIABLE	COEFFICIENT	T-STAT
AVTS29	3.446	0.730
PHS30	5.746	0.514
PHS31	8.494	3.787**
PHS32	4.370	1.704*
PHS33	27.193	2.432**
PHS34	15.297	7.202**
PHS35	16.132	7.318**
PHS36	27.659	7.688**
AVTS37	11.792	5.202**
AVTS38	12.088	1.077
PHS39	-8.334	-2.388**
PHS40	16.486	3.985**
AVTS41	8.931	2.475**

** Significant at the 5% level.
* Significant at the 10% level.
Adjusted R-Squared = .28

The next regression utilizing this data set is reported in Table 5.14. This linear regression includes as explanatory variables the student and school characteristics, but does not include the school dummy variables.

At this point, each variable will be examined in detail. Beginning with ACAD, which is a dummy variable that labels the test taker as either academically disadvantaged or not, this variable has predictably presented a significant, negative coefficient every time it has been used as an explanatory variable. Students who have an academic disadvantage, as defined by the ODVTE, will not do as well on the Salesperson occupational competency exam as other, non-disadvantaged students.

Consider next the variable called ACT which is the mean composite ACT score for the school, or in the case of AVTS, it is the weighted average of the mean ACT scores for the appropriate feeder schools to the AVTS. As ACT scores increase, the prediction was

TABLE 5.14[1]

Salesperson
Student and School Characteristics

VARIABLE	COEFFICIENT	T-STAT
C	79.194	6.534**
ADULT	-0.599	-0.964
ECON	-2.968	-2.279**
ACAD	-8.413	-6.322**
GENDER	-0.032	-0.486
MINORITY	-1.614	-1.323
ACT	-0.516	-1.190
COST$	0.0002	0.447
PERACA	0.109	3.140**
PERECO	0.030	0.852
PERNON	-0.023	-0.846
AVTS	-3.953	-1.187
WRIT	0.199	4.461**
DECA	0.694	5.526**

** Significant at the 5% level.
Adjusted R-squared = .12

that occupational competency scores would increase as well. This variable showed no statistical significance in the Salesperson regression. In fact, the only place that the ACT variable has been significant, even at the 10% level, was in the General Electronics

[1] The same specification was tested for the 119 Salesperson scores that originated from the AVTS only. Continuing their significance at the 5% level were WRIT and ACAD. DECA was significant at a 13% level. ECON and PERACA both lost their significance. All signs remained the same.

One reader suggested utilizing the DECA variable as three dummy variables: DECA1 for zero wins, DECA2 for a median number of wins, and DECA3 for a large number of wins. When attempted, this did not improve the explanatory power of the variable or of the model.

Technician regression; however, the coefficient in that case was negative. Actually, the ACT variable has had a negative coefficient in all regressions executed, including the Salesperson case. Interpreted, this means that as ACT scores increase, a school can be expected to do *worse* on the occupational competency exams. Why might this be the case? Consider what the ACT attempts to measure. Essentially, it attempts to measure the preparedness of a student for college. If a school posts a high mean ACT score, it is presumably doing a good job at preparing its students for college, but nothing can really be said about how well the school prepares students to take vocational courses. In fact, it might be speculated that schools which put emphasis on college readiness, and therefore post high mean ACT scores, actually under-emphasize vocational goals, thus creating a possible negative relationship between ACT scores and occupational competency exam scores.

The variable AVTS indicates whether the test score originated from a comprehensive high school or from an area vocational technical school. Recall that in the Manager Trainee data set this variable had a negative coefficient, but was not statistically significant. This remains true in this large salesperson data set.

Again, the COST$ (spending per student) variable failed to achieve any significance. The traditional prediction is that as spending per student increases at a school, then student performance should increase as well. This study of vocational occupational competency exams has supported this theory only in the case where guidance dollars could be measured. In all other cases, the effect has either been negative or not significant.

On the other hand, the DECA variable (number of wins per school at the state DECA competition) did perform well, posting a positive significant coefficient. This indicates that the schools with the most active DECA chapters produce students that do well on the competency exams. Two possible explanations exist. Either these schools have active DECAs because the teacher is active which translates into higher test scores, or the students become more competent in their field as they get more involved in the DECA program. Both explanations likely play a role in creating the positive relationship.

Do students with an economic disadvantage do worse on the occupational competency exam? Based on the Salesperson regression, the answer is "yes." Recall that previous regressions gave no statistical significance to ECON. It could be that only with this final regression have enough observations been available to allow the relationship to present itself. Also, beware of generalizations. This relationship could be true for Marketing Education but not for General Electronics.

For the Salesperson data set, the ADULT variable showed no statistical significance. Unlike the Manager Trainee data set in which the students were almost exclusively high school seniors, the Salesperson data was a near even split between high school juniors and seniors with a few adult students present. Even so, it does not appear to matter. High school juniors and seniors and adult students all do equally well on the Salesperson occupational competency exam.

Recall that PERNON describes the percent of students taking a test whose race is categorized as nonwhite. PERNON was significantly negative for the General Electronics and for the Manager Trainee regression. The Salesperson regression does not attach statistical significance to the coefficient of PERNON. The percent of test-takers that is nonwhite has no impact on Marketing Education test scores from that occupational exam.

Similarly, the Salesperson regression assigns a positive coefficient to PERECO (as did General Electronics and Manager Trainee); however, this model did not show the coefficient of PERECO (percent of test group with an economic disadvantage) to be statistically different from zero.

The results for PERACA (percent of test group with an academic disadvantage) represent a substantial divergence from earlier regressions. PERACA is significant; however, its sign is positive indicating that when more academically disadvantaged students take the exam, overall scores increase. It is possible that, when grouped together, a large number of academically disadvantaged students feel more at ease, feel less pressure to perform, and, consequently, do better on the exam.

Like earlier ones, this Salesperson regression shows the variable MINORITY (student is a racial minority) to be statistically insignificant. In this particular data set, 697 students categorized themselves as white, 102 as African American, 42 as Native American, 13 as Asian, and 10 as Hispanic.

The variable GENDER, indicating male or female student, continues to lack any explanatory power. Males and females do equally well on the Salesperson exam.

Finally, WRIT is the percentile ranking of the school on the 1993 Tenth Grade Stanford Writing Test. As the percentile rank of the school increases, this indicates that students at the particular program site have better writing and test-taking skills, and, therefore, occupational test scores should increase. This was exactly the result achieved by this variable in the Salesperson regression. The coefficient of WRIT was significant and positive.

Since some program sites do, in fact, perform better than others on the occupational competency exams, various characteristics of some of the significant sites were compared across schools. Those comparisons are located in Table 5.15.

Please note that the top 10 ranking sites were chosen for analysis; however, three of those ten were represented by only one test score, and one site reported only three test scores. Due to low representation, those four sites were not discussed in Table 5.15. The remaining sites are compared to the worst performer, PHS39.

With respect to their test scores, all of the six top- ranking schools did, in fact, have higher than average scores. As expected, the lowest-ranking school reported test scores that were well below average.

Notice the index for ACT. All seven schools, including the lowest-ranked site, posted an index for ACT that was very close to the mean ACT score. This is most likely a result of a very small standard deviation for this variable, equal to 1.48. As the linear regression for this data set indicated, ACT does not seem to be a good explanatory variable for occupational test scores.

The index for WRIT, on the other hand, is a bit more interesting. With only one exception, all of the highest- ranked sites reported WRIT scores which were higher than average. The one exception, PHS35 (rank 4), posted a WRIT score that was barely more than half of the average score; however, the other indices for PHS35 appear to be fairly close to average. PHS35 may be an anomaly. However, PHS39, ranked 41st, obviously has a WRIT score that is less than average. Their score was approximately 69% of the mean. WRIT continues to perform quite well, causing one to draw the conclusion that students with good writing skills, or who come from a feeder school which teaches writing skills, will outperform other on the occupational competency exam.

TABLE 5.15

Characteristics of Significant Sites: Salesperson

RANK	SITE CODE	Index SCORE	Index ACT	Index WRIT	Index DECA	Index COST	Index %NON	Index AVG. SALARY
Mean		1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.	PHS36	1.218	0.929	1.123	0.407	0.960	1.338	1.139
2.	PHS10	1.258	1.061	1.040	0.407	0.862	0.633	1.029
3.	PHS40	1.106	1.095	1.206	0.808	1.225	0.686	1.113
4.	PHS35	1.083	0.891	0.520	0.610	0.960	1.399	1.158
5.	PHS25	1.088	1.061	1.622	0.808	0.989	0.587	1.042
6.	PHS34	1.105	1.080	1.102	2.642	1.151	0.648	1.106
41.	PHS39	0.000	0.949	0.686	0.000	0.869	1.167	1.041

TABLE 5.15
(Continued)

RANK	SITE CODE	Index ADV. DEGREE	Index TEACHER EXP.	* Percent H.S.GRADS in COUNTY	* Percent VOTER REG. in COUNTY
Mean		1.000	1.000		
1.	PHS36	1.463	1.239	0.97%	71%
2.	PHS10	1.057	1.197	0.96%	67%
3.	PHS40	0.987	1.265	1.18%	72%
4.	PHS35	1.419	1.410	0.97%	71%
5.	PHS25	2.289	1.214	1.08%	71%
6.	PHS34	1.047	1.026	0.97%	71%
41.	PHS39	1.103	1.077	0.62%	69%

The index for COST$ reveals no new, interesting information, but notice the DECA index. All of the top-ranking sites had winners at the state DECA competition. The lowest ranking site, PHS39, either had no winners or entered no students into the competition.

The results for PERNON can also be interpreted in a very interesting way. At first glance, it appears that no relationship exists between test scores and the percentage of minority students within the test group. Look again. All of the top six schools posted PERNON indices that were either well below or well above average. For instance, the highest-ranking site, PHS36, has approximately 34% more minority students than an average school. Sites ranked 2 and 3, respectively, have indices which indicate they have 37% and 32% fewer minority students than an average school. In general, the best schools have either a very high enrollment of minorities or a very low enrollment of minorities (relative to average) in the ranges of 31%-41% below average and 34%-40% above average. Note that the lowest-ranked site has an approximately average enrollment of minority students. This result appears to support the finding of Link and Mulligan (1991) that students are sensitive to the racial mix of their classmates and tend to do better when the percentage of students of their own race is higher (whether the student is a minority or not).

In order to test statistically for the existence of patterns like the ones examined in Table 5.15, an additional test was executed. The following school characteristics were used as independent variables: AVTS, DECA PERNON, PERACA, PERECO, and COST$. These variables were used to explain the variation in the coefficients assigned to the specific school sites in Table 5.13. Once again, this type of test failed to uncover any statistically significant relationships. Refer to Table 5.16.

When each variable was tested alone, (for example COST$ is the only independent variable explaining school site coefficients) only one variable was significant enough to create a positive adjusted R-squared. That variable was PERECO (percent of test group that is economically disadvantaged), and it was significant at the 13% level and positive. Refer to Table 5.17.

TABLE 5.16

Test for Patterns Among Site-Specific Independent Variables
Dependent Variable: Coefficient of the Specific Site

VARIABLE	COEFFICIENT	T-STAT
C	5596.516	0.675
COST	-1.186	-0.754
AVTS	-73.080	-0.024
PERACA	-10.793	-0.198
PERECO	62.760	1.182
PERNON	51.726	1.000
DECA	41.747	0.126
Adjusted R-Squared = -0.067		

TABLE 5.17

Independent Variable: PERECO
Dependent Variable: Coefficient of the Specific Site

VARIABLE	COEFFICIENT	T-STAT
C	-28.452	-0.019
PERECO	71.074	1.528
Adjusted R-Squared = .005		

CHAPTER VI

IMPLICATIONS AND CONCLUSIONS

A Summary of Results

For a comprehensive summary of results, refer to Table 6.1. The most consistently performing variable was ACAD. For instance, ACAD posted negative coefficients each time, and it was statistically significant in every execution. Educators can probably expect a student who has been categorized as academically disadvantaged to post lower scores on occupational exams in both General Electronics and in Marketing Education.

The variable ECON (student has an economic disadvantage) was consistently assigned a negative value. In the General Electronics and Manager Trainee exams, this was not a significant variable, and the speculation was made that conflicting motivations in economically disadvantaged homes may cause signs on ECON to be no different than zero. The Salesperson execution did, in fact, attach significance to the negative sign, indicating that economically disadvantaged students will likely do worse on, at least, the Salesperson occupational competency exam. However, when the Salesperson scores were tested for the area vocational schools only, ECON again lost its significance.

PERNON (percent of test group that is non-white) turned out to be an interesting variable in this study. Although the coefficient was insignificant in the Salesperson data set, PERNON posted a significantly negative coefficient in the Manager Trainee and General

Electronics data sets. In these two data sets, as the percentage of minority students within the test group rose, test scores fell.

TABLE 6.1

Comprehensive Summary of Results

	GENERAL ELECTRONICS	MANAGER TRAINEE	SALESPERSON
ADULT	**+**	+	-
ECON	-	-	**-**
ACAD	**-**	**-**	**-**
GENDER	-	+	+
MINORITY	-	-	-
PERACA	**-**	-	**+**
PERECO	**+**	+	+
PERNON	**-**	**-**	-
COST$	N/u	**+**	+
WRIT	-	**+**	**+**
ACT	+	**-**	**-**
GUIDANCE$	**+**	N/u	N/u
INST$	**-**	N/u	N/u
ADMIN$	**-**	N/u	N/u
AVTS	N/u	-	-
VICA/DECA	**+**	+	**+**

Larger, bolder type indicates significance at the 10 percent level, at least.
The entry "N/u" indicates that this variable was not used in the particular regression.

Even though the coefficient of PERNON was not significant in the Salesperson specification, recall that a review of characteristics of the best and worst test sites for this data set (Salesperson) indicated that the best schools had either well-above-average

PERNON or well-below-average PERNON indices. The worst schools had near average values for PERNON. This provides some weak support to prior evidence by Link and Mulligan, which suggests that students are sensitive to the racial mix of their class. To reconcile the two findings concerning PERNON, it may be fair to suggest that for small test groups, increases in the percentage of nonwhite test-takers will lower test scores. At some point, however, the size of the test group may become large enough to allow the other result to emerge – that both white and nonwhite students are sensitive to the racial mix of their test group.

Evidence concerning other test group mixes is not quite as conclusive. PERACA (percent of the test group that is academically disadvantaged) was significant and negative, as predicted, for the General Electronics data set, but was significantly positive for the Salesperson data set. Interestingly enough, PERECO (percent of the test group which is economically disadvantaged) showed an unusual tendency to affect scores positively. If, as speculated, lower income families emphasize vocational training at home, then it is possible that a large grouping of economically disadvantaged students may create an atmosphere of comradery that may explain why test scores rise under these conditions.

The variable VICA(DECA), which measures the number of wins per school at state VICA(DECA) competitions, appears to be a good indicator of test scores. In all scenarios, this variable affected test scores positively, and in two of the three cases, it was statistically significant. It was hoped that VICA(DECA) could be viewed as an alternative type of measurement of the contribution of the teacher to the educational process. For this purpose, it appears to have been something of a success.

The variable AVTS, which indicates a test site that is an area vocational school, was not required for the General Electronics data; however, when AVTS was utilized for the Marketing Education data sets, it failed to achieve statistical significance in either set. The evidence seems to suggest that students will not do better (or worse) on the occupational competency exam if they enroll in Marketing Education courses at comprehensive high schools or at area vocational technical schools.

Recall that the variables GUIDANCE$, INST$, and ADMIN$, which measure spending per student for guidance and counseling, instructional support, and administration, apply only to the General Electronics specification. Results from these variables are mixed. Spending on guidance and counseling may increase test scores, while spending on administrative and instructional support may lower test scores. When the relationship between spending and test scores was examined for the Marketing Education groups using COST$ (spending per student) as an explanatory variable, the finding was that additional dollars to education do not increase test scores.

Implications

Ever since the publication of the Coleman Report, educators have been concerned that the main indicators of success in school are socio-demographic characteristics that are beyond the control of the school system. Such characteristics include race and economic status of the parents. This study of vocational programs in Oklahoma may present some evidence to the contrary, at least where vocational education is concerned. Frankly, there is not much evidence to support the hypothesis that the economic background of the student makes a significant difference in determining how well a student will perform on the occupational competency exams. Likewise, there is even less support for the hypothesis that racial minorities (who are often economically disadvantaged) will perform poorly on these exams.

Why should vocational programs and secondary high school programs differ in this respect? As discussed earlier, it is possible that higher income families do not encourage participation in vocational programs at all. Instead, such families are preparing their children for college and promoting academic pursuits over vocational ones. On the other hand, poorer families may be discouraging their children from considering college because of financial concerns. These same families may feel that vocational training on the secondary level is crucial – in fact, may believe that vocational education is the only opportunity their children may have for becoming productive members of the work force. For vocational educators, this kind of suggestion should renew their own faith in their mission.

Vocational educators should not especially worry about a student's economic background (with respect to test scores). This statement represents the first of many implications of this particular study (implication 1). Researchers in the field of "economics of education" must remember that college-prep outcomes and vocational outcomes are not equivalent, and factors which consistently are found to be important in the determination of one outcome will not necessarily be found to be important in the determination of the other.

Another example of this phenomenon is the ACT variable. This variable is commonly used and often found to be important in determining college-prep outcomes. However, the ACT does not attempt to measure vocational skills, and, consequently, one should not expect it to be a significant determinant of vocational outcomes.

Implication 2 is that this study may provide further evidence (Link and Mulligan, 1991) that students are sensitive to the racial mix of their classrooms or test groups. Minority students may be more comfortable in a group made up largely of other minorities. The same may be true for Caucasian students who may be more comfortable in a largely white classroom. This conclusion is certainly not written in stone; nevertheless, it points to the relevance of studies on school bussing policies, for instance. Specifically, a cost/benefit study of a bussing program that would attempt to value the possible drop in scores (or rise in scores) could make some interesting discoveries.

Vocational educators may find implication 3 to be quite reassuring. Apparently, it does not make a difference where students enroll in Marketing Education courses. Programs at AVTS and comprehensive high schools perform equally well. Of course, this cannot be generalized across all vocational programs.

Additional spending on a program does not necessarily lead to higher test scores. Implication 4 is really nothing new. Production function studies of college-prep outcomes have indicated for years that additional dollars to a program may have zero or possibly even negative marginal returns. This study provides fairly strong evidence that this relationship may apply to vocational outcomes as well as to college-preparatory outcomes.

Implication 5 suggests that although vocational educators may not need to especially worry about economic backgrounds of students, they do, in fact, need to consider the academic challenges faced by their students. Most certainly, students with an academic disadvantage will not perform as well on the occupational competency tests as will other students. As an economist, I am not qualified to suggest what educators should do with this information, but I do believe it is a finding which needs their attention.

Unfortunately, this study provides no concrete evidence concerning how the mix of academically disadvantaged versus non-disadvantaged students within a test group will affect test scores. In some cases, the variable took a negative value; in other cases it took a positive value. The economic justification for this variable to be negative is so strong that I recommend further investigation of this topic. The issue is rather timely considering the current trend in elementary and secondary education to "mainstream" academically challenged students into "normal" classrooms.

One of the more baffling implications of this particular educational production function study (implication 6) is that as the percentage of economically disadvantaged students within a test group rises, test scores may actually rise. This outcome requires additional attention, I believe, in order to discover the basis for this relationship.

Implication 7 is not so surprising. When students have better writing skills, they appear to perform better on the occupational competency exam. This implication may require some attention by the Oklahoma Department of Vocational and Technical Education. If it is possible for the ODVTE to assist in the upgrading of its students' writing skills, it may be worth it in that it will likely improve their outcomes on competency exams.

The teacher input to education has baffled researchers for decades. If traditional measures such as teacher salary and educational attainment do not seem to work (Hanushek, 1986), what does? It is possible that other methods, such as those that measure the level of involvement by the teacher, may be of more value in describing student performance than the traditional methods (implication 8). The VICA(DECA) variable was suggested to me by an administrator who believed that he observed the relationship in action. Perhaps researchers would be taking a step in the right direction by listening to the advice of principals and administrators concerning how best to measure the teacher input. Obviously, not every educational production function study will be able to utilize a VICA(DECA) variable; however, it seems likely that similar measurements could be available in many circumstances. Even so, I believe that it remains important for researchers to continue testing new hypotheses concerning the contribution of the teacher.

Finally, an important finding of this study is that different schools definitely produce different test scores. Some "traditional school characteristics" do account for those differences. These include racial mix of the test group and the teacher. Many of the traditional school inputs, however, did not have a consistent impact on outcomes. These include ACT scores, spending per student, and academic mix of the test group. I think, clearly, there are additional important inputs to vocational education that have not been addressed by this production function. The final implication of this study is that vocational educators are now challenged to discover these other sources of differences in school performance. It is apparently *not* dollars. It is *not* ACT scores. What *is* it? Again, this is a challenge to vocational educators who must examine the differences between the best schools and the worst schools and find those aspects of the programs that cause the students to either excel or to fall short.

Concluding Remarks

How can educators produce "better" students? Economists and educators have been asking this question since at least 1966. Even though educational production functions studies are common, researchers are still searching for their answers. Only recently have vocational educators developed a measure of vocational ability in the form of the performance-based occupational exam series. In 1993-94, these tests were still in their infancy. As the scope of such testing continues to grow, researchers will undoubtedly refine and redefine this model for how inputs to vocational education affect test scores. Although vocational educators did not necessarily develop the competency test for the purpose of serving as an "output," economists will surely jump at the chance to use this identifiable measurement as an output variable. It is, of course, only natural that economists and vocational educators should both be asking questions about how to improve this "output."

The series of production functions for vocational programs presented in this study were designed to initiate this process. They only represent the groundwork for future discoveries. Even so, these production functions present some exciting clues about how vocational education is produced. For instance, family income may not be as important a factor in achieving vocational success as it is thought to be in determining other forms of academic success. Also, peer group effects do seem to play a role in both traditional and vocational education.

This study did not answer all the questions that vocational educators have. It also should be stated that the opinions expressed in this research represent the opinions of the author and do not necessarily represent those of the ODVTE. Hopefully, however, the Oklahoma Department of Vocational and Technical Education will continue to pursue the lofty goal of better outcomes. Perhaps, the ODVTE will even adapt this research to suit their own needs and to examine the larger and more diverse group of occupational exams that is now available.

In conclusion thanks is offered to the Oklahoma Department of Vocational and Technical Education for their assistance, patience, and vision.

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APPENDIX A

TABLE A

TABLE A

Descriptive Statistics: Students

DATA SET	Total	Adults	9th	10th	12th	11th	Number of Students with an Academic Disadvantage	Number of Students with an Economic Disadvantage
Gen. Elec.	231	95	0	0	50	86	35	61
Mgr. Trainee	101	7	0	0	2	92	10	9
Salesperson	864	10	1	32	398	423	131	135

TABLE A
(Continued)

DATA SET	Male	Female	Native American	African American	Hispanic	Caucasian	Asian
Gen. Elec.	206	25	12	13	2	203	1
Mgr. Trainee	35	66	8	9	3	79	2
Salesperson	287	577	42	102	10	697	13

APPENDIX B

TABLE B

TABLE B

Descriptive Statistics: Program Sites

	AVTS SITES/ TOTAL SITES	MEAN	STD.DEV.	MINIMUM	MAXIMUM
General Electronics	17/17				
SCORE		65.18	11.35	31.00	94.00
ACT		20.24	0.71	19.07	21.30
PERACA		16.6%	18.0%	0	50.0%
PERECO		27.8%	24.8%	0	75.0%
PERNON		10.9%	9.9%	0	38.0%
WRIT		49.76	4.17	44.00	61.00
COST		$5886.79	$1894.15	$3419.00	$9204.00
Manager Trainee	4/13				
SCORE		66.70	16.80	22.00	94.00
ACT		20.32	0.94	16.90	22.20
PERACA		9.8%	12.9%	0	100.0%
PERECO		8.9%	16.6%	0	100.0%
PERNON		22.0%	23.5%	0	100.0%
WRIT		46.92	8.30	33.00	56.31
COST		$5481.24	$561.81	$4565.00	$6164.00
Salesperson	12/42				
SCORE		75.04	13.09	17.00	97.00
ACT		20.55	1.48	15.30	22.70
PERACA		14.3%	15.9%	0	100.0%
PERECO		15.5%	16.8%	0	100.0%
PERNON		20.3%	20.5%	0	100.0%
WRIT		48.1%	11.5%	25.00	78.00
COST		$5254.05	$1101.17	$2813.00	$9204.00

APPENDIX C

TABLE C

TABLE C

Salesperson
Vo-Tech Students Only

VARIABLE	COEFFICIENT	T-STAT
C	14.592	0.801
ADULT	-1.791	-1.180
ECON	-0.858	-0.240
ACAD	-11.437	-3.132**
GENDER	-3.250	-1.371
MINORITY	-1.610	-0.501
ACT	1.614	0.645
COST$	-0.001	-0.421
PERACA	0.003	-0.053
PERECO	0.105	1.173
PERNON	-0.128	1.026
WRIT	0.980	2.157**
DECA	0.671	0.135

** Significant at the 5% level.
Adjusted R-Squared = 0.34

APPENDIX D

INSTITUTIONAL REVIEW BOARD FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 11-04-97 **IRB#:** BU-98-012

Proposal Title: **A PRODUCTION FUNCTION FOR VOCATIONAL EDUCATION IN OKLAHOMA**

Principal Investigator(s): Ron Moomaw, Suzette D. Barta

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING, AS WELL AS ARE SUBJECT TO MONITORING AT ANY TIME DURING THE APPROVAL PERIOD.
APPROVAL STATUS PERIOD VALID FOR DATA COLLECTION FOR A ONE CALENDAR YEAR PERIOD AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Disapproval are as follows:

Signature: John H. Wyckoff

Chair of Institutional Review Board

Date: November 4, 1997

cc: Suzette D. Barta

2

VITA

Suzette Dragoo Barta

Candidate for the Degree of

Doctor of Philosophy

Thesis: A PRODUCTION FUNCTION FOR VOCATIONAL EDUCATION IN OKLAHOMA

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