THE PUBLIC BENEFITS OF HIGHER EDUCATION:
EXAMINING THE RELATIONSHIP BETWEEN STATE SPENDING ON
HIGHER EDUCATION AND THE FORMATION OF HUMAN CAPITAL

Matthew Craig Herndon

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Educational Leadership and Policy Studies

Dr. Steven M. Janosik, Chairperson
Dr. Mido Chang
Dr. Joan Hirt
Dr. John Muffo
Dr. Monty Sullivan

March 18, 2008
Blacksburg, Virginia

Keywords: economics, higher education, human capital, state spending

Copyright 2008, M. Craig Herndon
THE PUBLIC BENEFITS OF HIGHER EDUCATION:
EXAMINING THE RELATIONSHIP BETWEEN STATE SPENDING ON
HIGHER EDUCATION AND THE FORMATION OF HUMAN CAPITAL

MATTHEW CRAIG HERNDON

ABSTRACT

This study contributes to the literature on the economic value of higher education by examining the extent to which a set of independent variables, including two measures of state spending on higher education predict the formation of human capital. The findings suggest that, in most states, increases in state spending per full-time equivalent enrollment in public higher education predict decreases in the formation of human capital, while increases in state spending per capita on public and private higher education predict increases in the formation of human capital. This suggests that the relationship between state spending on higher education and the formation of human capital is dependent on the measure of state spending used. Attempts to increase the formation of human capital should focus on increasing state spending per capita on public and private higher education.

This study also analyzes time-series data from states, grouped by income inequality and changes in productivity, to examine the extent to which changes in a single measure of state spending on higher education predict changes in the formation of human capital. The results indicate that increases in state higher education spending do not benefit all states. Increases in state higher education spending predict increases in the formation of human capital in states with low productivity growth and in states with low levels of income inequality. In states with high productivity growth, increases in state higher education spending predict decreases in the formation of human capital.
# TABLE OF CONTENTS

**SECTI0N**

**ABSTRACT**

DEDICATION........................................................................................................v

ACKNOWLEDGMENTS.........................................................................................vi

LIST OF TABLES.......................................................................................................viii

LIST OF FIGURES.....................................................................................................ix

**CHAPTER 1**........................................................................................................1

INTRODUCTION.......................................................................................................1

Benefits of Higher Education..................................................................................2

Public Benefits of Higher Education.....................................................................5

Statement of the Problem.......................................................................................12

Purpose Statement...............................................................................................13

Research Questions............................................................................................15

Significance of the Study.....................................................................................15

**CHAPTER 2**.......................................................................................................17

REVIEW OF THE LITERATURE...........................................................................17

Public Economic Benefits of Education.............................................................17

Productivity.........................................................................................................25

Income Inequality...............................................................................................27

Relationships between Factors..........................................................................35

Obstacles to Studying Economic Benefits at the State Level..............................39

**CHAPTER 3**.......................................................................................................47

METHODOLOGY....................................................................................................47

Sampling Procedure...........................................................................................47

Data Sources and Collection Procedures..........................................................48

Data Analysis.......................................................................................................56

**CHAPTER 4**.......................................................................................................60

STATE SPENDING ON HIGHER EDUCATION AND THE FORMATION OF
HUMAN CAPITAL..................................................................................................60

Abstract...............................................................................................................60
CHAPTER 5
AN ANALYSIS OF STATE HIGHER EDUCATION SPENDING AND THE FORMATION OF HUMAN CAPITAL IN THE CONTEXT OF EXTREMES IN INCOME INEQUALITY AND PRODUCTIVITY CHANGE

Abstract
Introduction
Theoretical Model
Methods
Results
Discussion

REFERENCES
DEDICATION

This dissertation is dedicated to my grandparents Dorothy and Harry Crump, whose love for education and learning has been our family’s most treasured heirloom. In honor of their sacrifice and devotion to the value of progress through education and the inherent good of learning, I submit this small work.
ACKNOWLEDGMENTS

I owe a great deal of gratitude to the following individuals for their contributions to this work. Their contributions vary from the intellectual assistance necessary to identify, craft, and refine an acceptable dissertation to the emotional support needed to sustain such a task. I could spend twice the amount of time it took to create this work in trying to repay them and still not have satisfied half my debt.

I thank my wife, Andrea Herndon, who encouraged me to pursue as much education as I could wish to obtain and who supported me while I did. Without her support, this dissertation and intellectual journey would not have been possible. I thank my mother, Susan Sweeney, who never failed to inquire about my academic progress and to inspire me by expressing her pride. I thank my siblings Barry, Scott, and Kim, for helping to shape my understanding of concepts that are fundamental to this work. I thank my mother- and father-in-law, Patricia and Carl Wilson, who provided much needed respites from dissertation, complemented by an equal amount of encouragement to complete it.

The faculty of Virginia Tech’s Higher Education Program and members of my committee have had the greatest impact on my academic development in the past five years. Dr. Joan B. Hirt helped me to refine my writing style in advance of this task and spurred my interest in human capital theory. Dr. John Muffo substantially broadened by professional interests in higher education policy and introduced me to statistical procedures that have magnified the value of this study. Dr. Monty Sullivan has challenged me to think of the important details while not losing sight of how all the details fit together. Dr. Don Creamer, although not a member of the committee, played a critical role in my academic development by challenging me to think of educational policy from numerous perspectives while stirring my interest in the convergence of affordability and access issues in the public value of higher education.

My advisor and committee chair Dr. Steven M. Janosik has been an exceptional mentor and Sherpa on the path to the doctorate. Dr. Janosik created the extraordinary balance of improving my work while giving me the freedom to explore my topic and grow from the very process of writing a dissertation. I could not have asked for any more.
I also thank my fellow doctoral students, past and present. In particular, Ian Austin was an excellent sounding board for the foundational concepts on which this dissertation took shape. Elaine Humphrey provided motivation throughout the writing and analysis stages of dissertation. Students of the Higher Education Program, members of the Center for Public Administration and Policy, and all those people who are mentioned above have helped in creating a remarkably brilliant doctoral student experience.
LIST OF TABLES

Table 1 Studies Examining Government Spending on Education and Income Inequality………………………………………………………………….38

Table 2 Summary of Variables, and Associated Item Descriptions, Data Sources, and Availability……………………………………………………………………………49

Table 3 Concurrent Predictors of Enrollment Rates………………………………………73

Table 4 Predictors of Change in Enrollment Rates Over 5- and 10-Years…………………75

Table 5 State Enrollment Rate Changes by Group, 1980-2005…………………………78

Table 6 Predictors of Enrollment Rate Change Over Five- and Ten-Years, by Enrollment Group ……………………………………………………………………………………………79

Table 7 First and Fifth Quintiles for Income Inequality and Changes in Productivity, 1980-2005…………………………………………………………………………………………93

Table 8 Predictors of Enrollment Change in Low and High Income Inequality States……………………………………………………………………………………………………97

Table 9 Predictors of Enrollment Change in Low and High Productivity Growth States……………………………………………………………………………………………………99
LIST OF FIGURES

Figure 1 Nature of Benefits and Beneficiary of Higher Education ...........................................3
Figure 2 Theoretically-Based Model of the Relationships between Investment in Higher Education, Human Capital, Productivity, and Economic Growth .................24
Figure 3 Kuznets Curve ................................................................................................................32
Figure 4 Theoretically Based Model of the Relationship between Higher Education Spending and Economic Growth ..............................................................................40
Figure 5 Theoretically Based Model of the Relationship between Higher Education Spending and the Formation of Human Capital .................................................................44
Figure 6 Theoretically Based Model of the Relationship between Human Capital and Economic Growth ......................................................................................................................45
Figure 7 Theoretically Based Model of the Relationship between Educational Spending and Economic Growth ........................................................................................................65
Figure 8 Theoretically Based Model of the Relationship between Higher Education Spending and the Formation of Human Capital .................................................................68
CHAPTER 1
INTRODUCTION

Research conducted during the past 40 years has examined the private economic benefits of higher education extensively (Baum & Payea, 2005a, Baum & Payea 2005b; Bowen, 1996; Carnegie Commission on Higher Education, 1973; Committee for Economic Development, 1973; Friedman, 2002; Hansen & Weisbrod, 1969; Leslie & Brinkman, 1988; Weisbrod, 1964). Grounded in the notion that the cost of higher education should be paid by its beneficiaries (Greenaway & Hayes, 2004), the results of such research have influenced public perception of the value of higher education in the United States and preceded a shift in higher education funding policy from models that favored strong state and federal support and lower tuition to models that favor moderate state and federal support and higher tuition (Callahan, 2001; Hauptman, 2001; Institute for Higher Education Policy [IHEP], 1998). Since 1975, tuition prices have substantially outpaced increases in the Consumer Price Index (Heller, 2001) such that the average price of tuition and fees at public, four-year colleges has increased by more than 350% in constant 2005 dollars (College Board, 2005). In the same period of time, the number of high school graduates has decreased slightly (1.6%) while enrollments at public institutions of higher education have increased by 47% (National Center for Educational Statistics, 2005a). Despite substantial increases in tuition, demand for higher education has grown.

Studies of the economic benefit of higher education have identified that the cost of education, though higher than it was three decades ago, produces, on average, greater private economic benefit than forgoing higher education (Heller, 1997; Leslie & Brinkman, 1988; Vedder, 2004a). In fact, the wage gap between college graduates and high school graduates has only grown much wider in the last 30 years (Baum & Payea, 2005b; McNeil, 1998; United States Census Bureau, 2000). As a result, studies highlighting the private economic benefits of higher education are believed to have augmented the support of policymakers for increases in the student’s share of the cost of education (Hauptman, 2001).

Evidence from research on the public and private benefits of higher education has been used by policymakers in the formulation of tuition policy by determining the share
of the cost the private individual and the public at-large, should pay (Bowen, 1964; Carnegie Commission on Higher Education, 1973; Committee for Economic Development, 1973; Hansen & Weisbrod, 1969; Leslie & Brinkman, 1988; Paulsen, 1998; Weisbrod, 1964). In seeking to determine the appropriate cost to be paid by the student (i.e., the private individual) and the cost to be paid by the government (i.e., the public), researchers have relied on the use of indicators of public and private benefit, assuming that the benefits received from higher education should be proportionally represented in the costs. Indicators of the private benefit of higher education that quantify the rate of return on investment are far more prevalent than those of indicators that quantify the public benefit of higher education (IHEP, 1998; Williams & Swail, 2005).

Benefits of Higher Education

A wide range of public and private benefits are believed to emanate from higher education. Researchers reporting on the private and public value of higher education have divided the benefits of higher education into four categories, based on the type of benefit derived and the primary beneficiary (see Figure 1). Categorization of benefits and beneficiaries has been used to articulate to policymakers those monetary and non-monetary benefits that accrue to society and the individual (IHEP, 1998). Figure 1 displays that the four categories of benefits include: private economic benefits, public economic benefits, private social benefits, and public social benefits. The public and private distinction in these categories refers to society and the individual, respectively, as the primary recipient of the benefit. The economic and social distinction in these categories refers to the monetary and non-monetary nature of the benefit, respectively.

Private Benefits of Higher Education

*Private economic benefits.* The private economic benefits of higher education refer to monetary benefits accrued by individuals as a result of participating in higher education (Leslie & Brinkman, 1988; IHEP, 1998). Private economic benefits of higher education have been classified as direct financial returns, financial options, hedging options, and non-market returns received by individuals (Rogers & Ruchlin, 1971; Weisbrod, 1964). Direct financial returns are those increases in earnings that may be attributed to education. Financial options refer to the value of the opportunity to gain further education (Weisbrod, 1964). For example, someone who completes the first year
### Figure 1. Nature of Benefits and Beneficiary of Higher Education (IHEP, 1998)

<table>
<thead>
<tr>
<th>Nature of Benefit</th>
<th>Private</th>
<th>Public</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>Private Economic Benefit</td>
<td>Public Economic Benefit</td>
</tr>
<tr>
<td>Social</td>
<td>Private Social Benefit</td>
<td>Public Social Benefit</td>
</tr>
</tbody>
</table>
of college has the option to complete the second year and so on. Hedging options refer to
the capacity of education to increase an individual’s ability to adapt to changes in the
nature of work brought on by new technology and innovation. Non-market returns are
those financial benefits an individual receives from performing tasks that may otherwise
have required paying someone else to perform. The ability to file one’s own income tax
return is an example of non-market returns received from higher education (Rogers &
Ruchlin, 1971). Of these private benefits, the greatest amount of research has been
focused on the direct financial returns that individuals receive in relation to their
educational attainment (Leslie & Brinkman, 1988).

Leslie and Brinkman (1988) conducted a meta-analysis of studies on the private
rate of return to investment in higher education and found that such rates are more
sensitive to costs than to earnings. This sensitivity to costs results in a decrease in the rate
of return on investment when public financial support for higher education decreases.
Leslie and Brinkman (1988, p. 9) caution that such private rate of return measures say
more about how much education costs than what it is worth. Further, calculations of the
private rate of return to investment in education are based on an underestimation of the
private benefits and an overstatement of costs that results in a major underestimate of the
private rates of return.

The underestimation of the benefits identified by Leslie and Brinkman (1988) is
the result of calculating only the monetary benefits that students receive in the form of
increased wages while ignoring other economic and all non-economic benefits received
as a result of participating in higher education. Other economic benefits obtained as a
result of participating in higher education include a higher likelihood of being employed
(Baum & Payea, 2005a; Williams & Swail, 2005), less time to find a job if unemployed
(DaVanzo, 1983), better fringe benefits (Mishel, Bernstein, & Allegretto, 2005;
Smeeding, 1983), and higher savings levels (Eller & Fraser, 1995) than those who do not
participate in higher education.

To summarize, there is an abundance of research on the private economic benefit
of higher education. Less research has been produced on benefits not directly related to
economic gains that accrue to individuals and benefits that accrue to society.
Private social benefits. The private social benefits of higher education refer to benefits accrued by individuals that are not directly related to monetary benefit. Studies of the private social benefits of participating in higher education find that such benefits consist largely of consumption and quality of life benefits (Hansen & Weisbrod, 1969; IHEP, 1998; Williams & Swail, 2005). Consumption benefits refer to the pleasure that individuals receive as a result of participating in higher education. Examples of consumption benefits include the access to sporting and cultural events while attending an institution of higher education, as well as the cultivation of a love of learning, cultural awareness, and an appreciation for fine arts that students may obtain as a result of higher education but carry with themselves well beyond graduation (Bowen, 1996). Such benefits are difficult to quantify, but no less important to understanding the benefits of higher education (Hansen & Weisbrod, 1969).

Quality of life benefits are often more specific and quantifiable than consumption benefits (Hansen & Weisbrod, 1969). Such benefits include better health (Mirowsky & Ross, 2003), lower smoking rates (Saad, 2002; de Walque, 2004), improved perception of health for the recipient of higher education (Baum & Payea, 2005a), improved quality of life for offspring as measured by the offspring’s high school graduation rates and cognitive development (IHEP, 1998), increased personal status (Terenzini, 1996), and participation in more leisure activities (IHEP, 1998).

Public Benefits of Higher Education

Public benefits of higher education are those monetary and non-monetary benefits accrued by society rather than an individual participant in higher education. Researchers have classified the public benefits of higher education by the effects that such benefits produce. Hansen and Weisbrod (1969) categorized the effects of higher education into classes: citizen effects, reduction in transfer effects, knowledge transmission and dissemination effects, and new knowledge effects. More recent studies have identified citizen effects as a public social benefit of higher education, and grouped monetary transfer effects, knowledge transmission and dissemination effects, and new creation knowledge effects into a super-category of public economic benefits (IHEP, 1998). Still, it is important to note that economic implications exist for the former category and social implications exist for the latter.
Public social benefits. Citizen effects are concerned with the benefits that higher education produces in the form of a more engaged citizenry (Hansen & Weisbrod, 1969). Dee (2004), in seeking to determine if higher education affects civic engagement, defined civic engagement in terms of voter participation, group membership, attitudes towards free speech, and newspaper readership. Researchers have consistently found that educational attainment in the United States is strongly and positively related to voter participation (Putnam, 1996; Milligan, Moretti, & Oreopoulos, 2004) and that education is correlated more strongly with voter participation than any other variable (Putnam, 1995). Building on these findings, Dee (2004) studied longitudinal data collected by the U.S. Department of Education on voting and other measures of civic engagement and found that participation in higher education positively affects voter participation. In addition, Dee (2004) found that group membership, attitudes toward free speech, and newspaper readership were each positively affected by participation in higher education.

Public Economic Benefits of Higher Education

Research studies on the public economic benefits of higher education have focused largely on reductions in wealth transfers and enhancements to economic efficiency and growth brought on by the creation, transmission, and dissemination of knowledge. Reduction in monetary transfer refers to the relationship between education and pecuniary redistribution, such as welfare assistance and unemployment payments. There is widespread evidence that higher levels of educational attainment are related to decreased representation in the lowest income bracket, or poverty (Vernez, Krop, & Rydell, 1999). Participation in higher education is also associated with reduced need for public health assistance (Galea & Ahern, 2005). And, as noted previously when discussing the private economic benefits of higher education, participation in higher education is associated with a higher likelihood of being employed (Baum & Payea, 2005; Howe, 1992; Williams & Swail, 2005) and less time to find a job if unemployed (DaVanzo, 1983). The negative associations between participation in higher education and poverty, participation in higher education and health problems, as well as participation in higher education and unemployment helps explain why individuals with high levels of education are less likely to receive welfare and unemployment transfers than those with low levels of education. Reduction in transfer effects are a redistributive
benefit of higher education, in that higher education does not add wealth in this area, it simply reduces the amount of wealth in society that is transferred from one person to another.

The remaining public economic benefits identified by the literature include new knowledge effects and increasing efficiency brought on by the transmission and diffusion of knowledge (Becker & Lewis, 1992; Bowen, 1996; Gittell & Sedgely, 2000; Keller, 2006; Vedder, 2004a). Evidence of the new knowledge effects of higher education has led researchers to conclude that the research function of higher education has a positive economic impact (Becker & Lewis, 1992). McMahon (1992) studied the direct effect of research productivity on economic growth and found that the largest effect of research on growth resulted from technical change embodied in new capital, while expenditures on higher education research effect growth directly. McMahon’s (1992) findings are consistent with that of Jaffe (1989) who found a significant direct effect of university research on corporate patents and indirect effect on local economic growth.

Regarding the knowledge transmission and diffusion effects of higher education, two opposing views have been used to describe the relationship between higher education and economic growth. Human capital theory and the theory of signaling and screening offer contrasting descriptions of the relationship between economic growth and higher education. Human capital theory is based on the premise that education raises the productivity of its recipients, thereby increasing wages (Bowen, 1964; Becker, 1993; Schultz, 1971). The theory of signaling and screening asserts that employers hire college graduates and pay them higher wages based on the signal that graduates emit, rather than the increases in productivity produced by a college education (Arrow, 1973; Spence, 1973; Stiglitz, 1975).

*Theoretical Explanations for the Economic Benefits of Higher Education*

According to human capital theory, education produces economic benefits, both private and public, through increasing productivity. Skills and ability gained through education that heighten productivity, are said to be human capital. Human capital theory posits that previously unaccounted for growth in the economy has been the result of investments in human capital (Becker, 1993; Schultz, 1971). This construct is supported
by the findings from a number of studies, including those conducted by Denison (1985), Jorgenson and Fraumeni (1993), Thomas, Wang & Fan (2001), and Hsing (2005).

Denison (1985) found that one quarter of the economic growth experienced in the United States between 1929 and 1982 was attributable to increases in human capital. Jorgenson and Fraumeni (1993) found that the labor market activities of those with higher education accounted for the tremendous economic growth experienced in the United States in the four decades following World War II. Thomas et al. (2001) found that increases in per capita gross domestic product (GDP), a measure of economic growth, were positively associated with the average years of schooling of the labor force. Hsing (2005) found that economic growth, as measured by GDP, was positively associated with the percentage of the population 25 years-old and older who had completed four years of college or more, a common measure of the stock of human capital.

According to the constructs of the theory of signaling and screening, employers use the college degree as a screening mechanism to hire workers who may be intellectually or otherwise predisposed to be more productive and less likely to be absent, use illicit drugs, or steal from the company than potential employees who lack a college degree (Arrow, 1973; Spence, 1973; Stiglitz, 1975). According to the theory, a college education does little to contribute to the productivity of its recipients. As a consequence of this theory, and research findings that appear to support it, some have argued that public money spent on higher education is wasteful. They propose that there are more efficient ways to screen for productive employees than public subsidies for higher education (Brown & Sessions, 2004; Keller 2006; Vedder, 2004a).

One research study examined the private and public returns to education by examining the relationship between state spending on higher education and measures of economic growth (Vedder, 2004a; Vedder, 2004b). The researcher, Eric Vedder (2004a, 2004b), concluded that his analysis supported the constructs of signaling and screening. Vedder (2004a) found that state spending on higher education, as measured by the proportion of state personal income spent by state and local governments, was negatively associated with economic growth, as measured by real personal income per capita. Moreover, Vedder’s study did not afford evidence that state spending on higher education
contributed to the formation of human capital, as defined by the portion of the population with college degrees.

Recent research has generally discredited a model of the relationship between higher education and economic growth that is based wholly on signaling and screening (Brown & Sessions, 2004). Human capital theory suggests, and empirical evidence supports the opposing view, that the relationship between state spending on higher education and productivity is more direct than state spending on higher education and economic growth (Becker, 1993; Hojo, 2003). Further still, research studies using a human capital framework have suggested the existence of variables not considered by Vedder in studying the relationship between state spending and economic growth.

Human capital theory states that education and training raise the productivity of its recipients (Becker, 1993; Bowen, 1964; Denison, 1984). And, while productivity and economic growth are strongly related such that productivity is a strong source of economic growth (Bureau of Labor Statistics [BLS], 2004; Clarke, Durand, Pilat, & Torres, 2001; Organization for Economic Cooperation and Development, 2006; Sweetland, 1996), the two concepts are not synonymous. In studying the relationship between education, productivity, and economic growth, Hojo (2003) found that education has a more direct impact on productivity than on economic growth. Human capital theory attributes economic growth to the gains in productivity realized from investments in human capital, such as education (Becker, 1993). Increases in educational spending that result in increases in educational attainment indirectly affect economic growth through direct improvements in productivity.

Much research has been conducted on the relationship between education spending and economic growth. Country-level findings from research that employs a human capital framework in studying the relationship between investment in education and economic growth are more conclusive than state-level findings of the relationship between higher education, specifically, and economic growth. A number of studies have identified a positive relationship between investment in education and economic growth (see Barro, 1991; Barro & Sala-I-Martin, 1995; Bassanini & Scarpet, 2001; Stevens & Weale, 2004), leading Greenway and Hayes (2004) to conclude that, “There is a considerable amount of evidence internationally [that] points to a positive association
between investment in education and economic growth” (p. 312). Using Organization for Economic Cooperation and Development (OECD) data and findings, Greenway and Hayes (2004) identified higher education attainment as the most relevant education variable among developed countries.

Productivity is strongly associated with measures of economic growth (BLS, 2004; OECD, 2006) and human capital theory holds that education directly increases individual productivity (Becker, 1993; Bowen, 1996; Mincer, 1974; Schultz, 1971). In addition to the identification of a direct relationship between productivity and human capital, recent studies of economic growth and human capital have identified income inequality as a factor that may be useful in understanding the relationship between higher education and economic growth in the United States (Bishop, Formby, & Thistle, 1992; Sylwester, 2002). Moreover, studies that employ a human capital theory framework in studying the relationships between government spending on education and income inequality may benefit from the use of new measures of human capital that account for the dispersion and distribution of income (Bishop, et al., 1992; Checchi, 2001; Thomas, et al., 2001). Studies that employ a human capital theory framework have identified relationships between government spending on education and productivity (Hojo, 2003), productivity and economic growth (BLS, 2004; Clarke, et al., 2001; OECD, 2006), productivity and income inequality (Becker, 1993; Denison, 1962), government spending on education and income inequality (Bishop, et al. 1992; Checchi, 2001; Sylwester, 2002), and income inequality and economic growth (Hsing, 2005; Panizza, 2002;).

**Productivity and Income Inequality**

Productivity, a measure of economic efficiency, is a significant source of economic growth (BLS, 2004; Clarke, et al., 2001; OECD, 2006). Human capital theory identifies a causal relationship between increases in education and increases in productivity (Becker, 1993; Mincer, 1974; Schultz, 1971). Studies of education and productivity have resulted in findings that support the claim made by human capital theorists that education raises productivity (Bishop, 1994; Black & Lynch, 1996; Denison, 1985; Jorgenson & Fraumeni, 1993). If spending on higher education raises attainment levels, then human capital theory would suggest that there should be an increase in subsequent productivity levels.
Income inequality refers to the distribution of income among members of a given population or economy. The relationship between income inequality and productivity stems from the theory of human capital. Human capital theory identifies that increases in productivity that result from participation in education permit those who possess greater amounts of education to command more money when trading their labor in the marketplace (Becker, 1993). Increases in education cause increases in productivity; when education is administered unequally, income inequality is a result.

The relationship between public (i.e., government) spending on education and income inequality has been examined in a number of research studies, most of which have focused on primary, secondary, or all levels of educational spending, rather than spending on higher education specifically. Cross-sectional studies have found that public educational spending and income inequality are positively related (Checchi, 2000, 2001; Bishop et al. 1992); while studies that employed a longitudinal methodology resulted in findings that indicate government spending on education and income inequality are negatively related. In a longitudinal analysis, Sylwester (2002) found that countries that devote a greater percentage of gross domestic product to public education have lower income inequality in subsequent years. Mayer (2001) found that higher levels of educational spending resulted in decreased levels of inequality in subsequent years.

A substantial body of literature exists on the relationship between income inequality and economic growth. This literature suggests that the relationship is complex and related to the relative development of an economy, the unit of analysis, and the duration of time studied. Country-level studies indicate that income inequality and economic growth are positively related (Barro, 1999; Checchi, 2001), while a state-level study indicates that income inequality and economic growth are negatively related (Hsing, 2005). Studies also indicate that a positive relationship exists between income inequality and growth across wealthier nations at a given point in time (Barro, 1999, 2000) while a negative relationship exists among poorer countries and at the sub-national level across time (Barro 1999, 2000; Hsing, 2005; Li, Squire, & Zou, 1998).

The studies cited above provide evidence of a relationship between government spending and productivity, productivity and economic growth, productivity and income inequality, government spending on education and income inequality, and income
inequality and economic growth. Human capital theory states that productivity and educational attainment are closely related such that education causes increases in productivity (Becker, 1993; Schultz, 1971). The results of these studies, while not specific to a state-level examination of the relationship between spending on higher education and economic growth, provide useful information in the identification of factors that may influence this relationship. For example, if spending on higher education raises attainment levels, then human capital theory would suggest that there should be an indirect effect on economic growth brought on by a direct improvement in productivity levels.

In summary, research on the benefits of higher education has influenced policy on the respective costs that individuals and the public should pay (Carnegie Commission on Higher Education, 1973; Committee for Economic Development, 1973; Hansen & Weisbrod, 1969; Leslie & Brinkman, 1988; Paulsen, 1998; Weisbrod, 1964). An abundance of research on the private benefits of higher education exists. Results of such studies suggest that the private benefits of higher education consistently exceed the costs. Far less research exists on the public benefits of higher education. And while existing research suggests higher education enhances civic engagement and reduces monetary transfer, evidence of the relationship between state spending on higher education and economic growth is inconclusive (Baum & Payea, 2005; Dee, 2004; DaVanzo, 1983; Milligan, Moretti, & Oreopoulous, 2004; Putnam, 1995; Putnam, 1996; Williams & Swail, 2005). Research using a human capital framework suggests the existence of factors that may influence the relationship between higher education and economic growth.

Statement of the Problem

Research on the private benefits of higher education has resulted in wide agreement that the private economic benefits of higher education exist and that these benefits alone consistently exceed the costs (Leslie & Brinkman, 1988; Paulsen, 1998). Research on the public benefits of higher education has afforded conclusive evidence of the capacity of higher education to produce citizen effects (Dee, 2004; Milligan, Moretti, & Oreopoulous, 2004; Putnam, 1995; Putnam, 1996), reduction in monetary transfer effects (Baum & Payea, 2005a; DaVanzo, 1983; Williams & Swail, 2005), and new knowledge effects (Jaffe, 1989; McMahon, 1992). Yet, state-level evidence of the
economic effects of higher education brought on by the transmission and dissemination of knowledge is limited (Aschauer, 1992; Gittell & Sedgley, 2000; Hansen & Weisbrod, 1969).

State funding policies for higher education have changed in the past 30 years, moving from models that include strong state support and low tuition to models that include reduced state support and higher tuition. Country-level data support the claim that higher education produces public economic benefit, but less research has been produced using data from the state-level (Camdessus, 2004; Sapir, 2004), due in part to an absence of data that support the claim that state spending on higher education increases the formation of human capital (Vedder, 2004a). In addition, theoretical and empirical evidence suggest that the relationship between productivity and state spending on higher education is more direct than economic growth and state spending. Further, studies that have been conducted at the state-level may not adequately account for all of the factors identified in the literature, thereby distorting the results.

Purpose Statement

The purpose of this study is to contribute to the body of research on the public economic benefits of higher education by examining the relationship between state spending on higher education and state-level formation of human capital using the lens afforded by the constructs of human capital theory. In the interest of overcoming the unique obstacles associated with measuring economic benefits of higher education at the state-level, a model of the relationship between state spending and the formation of human capital is constructed based on human capital theory literature. The ability of the model to explain the overall variability of human capital formation will be tested. Following the overall exploration, a longitudinal analysis will be conducted to determine if within state changes in spending on higher education predict subsequent changes in the formation of human capital.

To accomplish this purpose, one study is undertaken in two phases. The first phase tests the relationship between state spending on higher education and the formation of human capital, using state higher education enrollment rate, a traditional flow measure of human capital that is not substantially affected by interstate migration of degree recipients and lag time between educational investment of the state and economic
productivity of the recipient. The relationship between state spending on higher education and the formation of human capital is tested by using time-series multiple regression procedures on state and local spending on public higher education per full time equivalent (FTE) enrollment at public institutions and state and local spending on public and independent institutions per capita, each independent variables, and the formation of human capital, the dependent variable. The study examines the concurrent relationship between variables and the extent to which changes in state spending on higher education predict future changes in the formation of human capital before examining how the regression coefficients may vary for states segregated by changes in enrollment level. Additional independent variables, identified by the literature, are included in the multiple regression equation to determine their relative ability to predict the dependent variable.

The second phase analyzes time-series data from states, grouped by income inequality and changes in productivity to examine the extent to which changes in state spending on higher education predict changes in the formation of human capital in the context of extremes in productivity and income inequality. The relationship between state spending on public and independent higher education per capita, the independent variable, and the formation of human capital, the dependent variable, is tested using multiple regression procedures that include additional independent variables identified by the literature.

Data Definitions and Sources

State higher education spending data were collected from the State Higher Education Executive Officers (SHEEO) and consist of (a) state and local appropriations for general operating expenses of public higher education less research, agriculture, and medical expenditures per public FTE and (b) state and local appropriations for general operating expenses of public and independent higher education per capita.

Flow human capital data were calculated by dividing total state enrollment in higher education data, collected from the Integrated Postsecondary Education Data System (IPEDS), by the state population age 18 to 24, collected from the U.S. Census Bureau’s Current Population Survey (Heller, 1996, 1999).

Productivity data, measured by per capita personal income, were obtained from the U. S. Bureau of Economic Analysis.
Income inequality data were collected from the U.S. Census Bureau and consists of income inequality coefficients (Gini coefficients) for each state ranging from 0 to 1, where 0 represents complete income equality and 1 represents complete income inequality.

Research Questions
The following questions are to be addressed in this study.

1. To what extent does state spending on higher education predict the formation of human capital?

2. To what extent do changes in state spending on higher education predict changes in the formation of human capital?
   a. To what extent does the predictive value of state higher education spending on the formation of human capital vary by changes in enrollment rate?
   b. To what extent does the predictive value of state higher education spending on the formation of human capital vary by state income inequality?
   c. To what extent does the predictive value of state higher education spending on the formation of human capital vary by changes in state productivity?

3. What factors are useful in explaining the relationship between state spending on higher education and the formation of human capital?

The first phase of this research will address research question 1 and question 2a. The second phase of this research will address research question 2b and 2c. The third research question will be addressed by the results of phases one and two.

Significance of the Study

There is a need to know more about the relationship between state spending on higher education and economic growth (Vedder, 2004a; William & Swail, 2005). Much of the research on the benefits of higher education has focused on the private economic benefit of higher education and the results of such studies have demonstrated that the private benefits consistently exceed the costs. This study intends to contribute to the body of literature on the economic benefits of higher education by examining the relationship...
between spending on higher education and a foundation of economic growth: the formation of human capital. To be clear, the formation of human capital is not an economic benefit unto itself, but the literature suggests that increases in human capital lead to increases in productivity, which leads to economic growth.

This study is intended to be significant to several constituencies. Policymakers may benefit from additional information on the relationship between state spending and the formation of human capital. In addition, this study may also benefit policymakers by examining the role of economic factors, such as productivity and income inequality, in the formation human capital.

Campus administrators and state-level higher education authorities may also benefit from this study. This study investigated the relationship between state funding for higher education and the formation of human capital, as measured by enrollment rates. A positive relationship may provide this constituency with support for sustaining state funding for higher education. A negative relationship may encourage this constituency to reexamine its strategies for seeking state funding for higher education as well as reexamine its internal allocation of funds.

Scholars of higher education and economics are provided with information for future research. An identification of factors that are useful in explaining the relationship between state spending on higher education and the formation of human capital may be used to inform new approaches to research on the relationship between human capital and economic growth. The research findings may encourage scholars to examine and further test other factors that influence the relationship between state spending on higher education and economic growth.

Organization of the Study

The study is organized around five chapters. The first chapter described the topic to be studied, the statement of the problem, the purpose of the study, the research questions, and the significance of the study. The second chapter reviews the literature that is significant to the study including the public economic benefit of higher education, human capital theory, productivity, and income inequality. The third chapter describes the methodology employed in the study. Chapters four and five represent manuscripts written for publication that address the research questions posed in chapter one.
CHAPTER 2
REVIEW OF THE LITERATURE

The purpose of this study is to contribute to the body of research on the public economic benefits of higher education by examining the relationship between state spending on higher education and state-level formation of human capital using a human capital theory framework. This study proposes consideration for the use of productivity and income inequality in measuring economic benefit. Using these factors and the constructs of human capital theory, a model is constructed and tested. The model examines the relationship between state spending on higher education and the formation of human capital. Following an overall exploration, longitudinal analyses are conducted to determine if within state changes in spending on higher education predict subsequent changes in the formation of human capital. States are then segregated by changes in enrollment rates, income inequality, and changes in productivity, to determine if the predictive values vary by group.

The review of the literature is divided into four sections. The first section is used to briefly review the body of literature on the public economic benefits of higher education with specific attention paid to human capital theory and the relationship between education, productivity and economic growth. The second section contains literature related to productivity. The third section provides a discussion of the literature on income inequality. The final section outlines models for describing the relationship between state spending on higher education and state-level economic growth that include income inequality and productivity.

Public Economic Benefit of Education

As described in the first chapter, research reports on the private and public value of higher education divide the benefits of higher education into four categories, based on the type of benefit derived and the primary beneficiary. While evidence from research substantiates private economic, private social, and public social benefits of higher education, research on public economic benefits of higher education has been less conclusive. The inconsistency of findings with regard to the public economic benefits appears to coincide with a specific means by which the public is believed to benefit. Three non-discrete schools of thought are used to explain the public economic benefits of
education: (a) reductions in monetary transfer (Baum & Payea, 2005a; DaVanzo, 1983; Hansen & Weisbrod, 1969; Vernez et al., 1999; Williams & Swail, 2005), (b) increases in productivity brought on by knowledge creation (Becker & Lewis, 1992; Jaffe, 1989; McMahon, 1992), and (c) increases in the productivity of laborers brought on by knowledge transmission and dissemination (Becker, 1993). More consistent evidence exists to support the public economic benefits derived from reductions in monetary transfer and the creation of knowledge than from the transmission and dissemination of knowledge.

**Reductions in Monetary Transfer**

The reduction in monetary transfer school of thought finds that governmental expenditures on education reduce the cost associated with other areas of governmental expenditure, thereby reducing the money transferred from one segment of society to another (Hansen & Weisbrod, 1969). According to this school of thought, society benefits economically from education by way of decreases in governmental services required (e.g. unemployment benefits, aid to needy families, and criminal justice expenses) and increases in the percentage of the population paying taxes, thereby reducing the burden to all (Williams & Swail, 2005). In this school of thought, education does not necessarily create economic growth so much as it diminishes the need to transfer wealth.

Support for the reduction in monetary transfer school of thought is found in the work of Vernez et al. (1999), Baum and Payea (2005a), Williams and Swail (2005) and DaVanzo (1983). Vernez et al. (1999) found that higher levels of educational attainment are related to decreased representation in the lowest income bracket, thereby reducing the government’s cost associated with aid to needy families. In addition, participation in higher education has been associated with a higher likelihood of being employed (Baum & Payea, 2005; Williams & Swail, 2005) and less time to find a job if unemployed (DaVanzo, 1983).

**Knowledge Creation**

Another way in which the public may benefit economically from investments in education is that of knowledge creation (Becker & Lewis, 1992; Jaffe, 1989). In studying the direct effect of university research on labor productivity and the indirect effect of
research via technical change embodied in new capital economic effects from 1960-1980, McMahon (1992) found that the largest effect of research on growth resulted from technical change embodied in new capital, while still expenditures on higher education research affect growth directly. McMahon’s (1992) findings are consistent with that of Jaffe (1989). Jaffe examined the spillover effects of university research and found a significant direct effect of university research on corporate patents and indirect effect on local economic growth.

While evidence from research supports the existence of economic benefits arising from reductions in monetary transfers (Baum & Payea, 2005; DaVanzo, 1983; Vernez et al., 1999; Williams & Swail, 2005) and increases in economic growth brought on by knowledge creation and technological advancements (Jaffe, 1989; McMahon, 1992), evidence of the relationship between spending on higher education and economic growth produced by knowledge dissemination and transmission is less conclusive. In addition, Becker and Lewis noted that 15-25% of growth in U.S. national income per employee was due to education, but historically, evidence has attributed this economic contribution to primary and secondary education more so than to higher education. In the absence of consistent evidence of economic benefit to society that arises from public expenditures on teaching and learning in higher education, it is difficult to justify expenditures for higher education that are not directly related to reductions in monetary transfer and the creation of new knowledge.

Knowledge Dissemination and Transmission

Researchers believe that the dissemination and transmission of knowledge resulting in increased levels of productivity is a third way in which education may provide economic benefit to society (Becker & Lewis, 1992). In this instance, dissemination and transmission of knowledge refers to the teaching and learning function of universities. According to the constructs of human capital theory, investments in teaching and learning are believed to raise the productivity level of individuals who receive education (Becker, 1993). The resulting increases in productivity thereby increase economic output and therefore contribute to economic growth (Hojo, 2003). The relationship between education and productivity is a major construct of human capital theory (Becker, 1993; Duncan & Hoffman, 1981; Mincer, 1974; Schultz, 1971).
Human Capital Theory

Human capital theory assumes that increases in education and training result in increases in productivity (Becker, 1993) and that unaccounted for economic growth is the result of the contributions of human capital (Becker, 1993; Schultz, 1971). Edward Denison (1962) initially found that three-fifths of income differentials were the result of differences in education. In a later study, Denison (1985) found that increases in education between 1929 and 1982 explained nearly one-quarter of economic growth during the period, as measured by increases in per capita income. Schultz (1971) and Becker (1993), both considered vanguards of human capital theory, cited the findings of Denison as evidence of a causal relationship between education and increases in economic growth.

The research findings produced by Denison (1962, 1985) are augmented by the findings of Duncan and Hoffman (1981) and Devroye and Freeman (2001) who all produced findings that give empirical support to the constructs of human capital theory. In examining the relationship between human capital and productivity, Duncan and Hoffman (1981) found that degree recipients were significantly more productive than less educated workers employed in similar positions. In examining the relationship between inequality of skills and inequality of earnings, Devroye and Freeman (2001) found that skills, as measured by scores on the International Adult Literacy Survey, were correlated with earnings in the United States.

In defining human capital, Becker (1993) broadly included education, training, and medical care as investments in human capital, on the premise that individuals may not be separated from the knowledge, skills, or health that they receive as a result of investments in these categories. Much of the research pertaining to human capital theory and economic output defines human capital in terms of attainment of education. Less often, studies of human capital theory and economic output define human capital in terms of employer-provided training (see Bishop, 1994). And even less often, studies of human capital theory and economic output define human capital in terms of personal health (see Berger, Howell, Nicholson, & Shadra, 2003; Rivera & Currais, 2003).

Regarding education specifically, individuals invest in education by paying for tuition and forgoing income during the period in which education is consumed. In return,
individuals expect to obtain an income that exceeds the cost of tuition and the cost of wages lost while consuming education (Sweetland, 1996). Society also invests in the education of individuals, and like individual investors, society expects a positive return on investment. Whereas individuals expect to receive returns in the form of increased personal income, society expects to gain from economic growth that is spurred by an educated workforce (OECD, 2006).

An analysis of per capita spending on education and economic growth from 1870 to 2000 found that in the United States, like the United Kingdom, Germany, and France, an inverse relationship existed prior to 1945 while a positive relationship existed from 1945 to 2000 (Carpentier, 2006). In seeking to determine the cause of the change in the relationship, Carpentier (2006) compared the United States with those countries that experienced the same change in relationship as well as those countries that did not experience a change in the relationship. He concluded that by 1945 some countries, including the United States, reached a threshold of human capital at which point the economies were driven by knowledge. The result of reaching this threshold of human capital was that spending on education shifted from minimizing the cost of production to improving the quality of the workforce. Increases in educational spending were then coupled with economic growth, while decreases in educational spending were coupled with economic decline.

Carpentier (2006) concluded that spending on education and economic growth have been positively associated in the United States since the end of World War II, yet his study did not examine the type of spending (e.g., primary, secondary, or higher education) that was correlated the strongest with economic growth. Evidence of positive public and private returns to human capital investment in primary and secondary education is abundant and well accepted (Becker & Lewis, 1992; Carpentier, 2006; Keller, 2006; Webber, 2002), as is evidence of private positive returns to human capital investments in higher education (Baum & Payea, 2005a; Carnegie Commission on Higher Education, 1973; Committee for Economic Development, 1973; Hansen & Weisbrod, 1969; IHEP, 1998; Leslie & Brinkman, 1988; Paulsen, 1998; Weisbrod, 1964). Yet, questions remain regarding the public rate of return on human capital investment in higher education, specifically regarding the effect of public spending on
higher education on economic growth (Hojo, 2003; Vedder, 2004a; Williams & Swail, 2005). First among these remaining questions is whether public investment in higher education positively affects the formation of human capital (Vedder, 2004a).

Studies of human capital typically measure the concept in one of two ways: stock data, such as the average educational attainment of a population, or flow data. Stock human capital is often measured as the average educational attainment of a population (Psacharopoulos & Patrinos, 2004) or the percentage of a population age 25 and older with a college degree (Hsing, 2005). Flow human capital, or the formation of human capital, is measured as the percentage of a population enrolled in higher education (McNamara, Kriesel, & Denton 1988; Psacharopoulos & Patrinos, 2004), or more specifically, the ratio of the total state enrollment in higher education data to the state population age 18 to 24 (Heller, 1996, 1999). In examining how human capital is measured, McNamara, et al. (1988) concluded that studies employing flow measures, those that account for the formation of human capital, were legitimate and necessary to understanding the relationship between human capital and economic growth.

The literature identifies that enrollment in higher education, a flow measure of human capital, is generally driven by two main factors: population growth and enrollment demand (Boilard, Simbol, & Kuhn, 2005). Increases in population may increase the flow of human capital. The literature identifies that factors driving enrollment demand include the price of student tuition, the availability of financial aid, and the availability and economic conditions such as the attractiveness of alternative options to education (Heller, 1996, 1999; Leslie & Brinkman, 1988; Macunovich, 1997; National Center for Educational Statistics, 2005b). Public investment in higher education is often aimed at increasing enrollment with the intention of improving economic growth (Greenway & Hayes 2004; OECD, 2006).

Longitudinal studies of the relationship of between state spending on education and the formation of human capital have found that the relationship is positive, but such findings are not specific to higher education spending. Mayer (2001) found that greater spending on secondary education was associated with higher rates of secondary school graduation and college enrollment in subsequent years. Checchi (2003) found that the
total amount of public resources expended on education had a positive effect on higher education enrollment.

Attempts to measure the relationship between public investment in higher education and economic growth have resulted in inconclusive findings. The reason for such inconclusive findings may be the result of methodologies that fail to account for more direct relationships that exist between state spending on higher education and economic benefit (Becker, 1993, Hojo, 2003). Vedder (2004a) found that state spending on higher education in the United States was negatively associated with state economic growth. Aschauer (1992) studied the public rate of return on investment in education in 107 countries during the period of time 1960 to 1985 and found a positive rate of return (9.4%). Aschauer (1992) then examined the rate of return on investment for primary, secondary, and higher education and found no difference in the returns rates. Neither study accounted for the direct economic effects that higher education is theorized to produce in the form of increases in productivity, nor did these studies attempt to determine if increases in public spending resulted in increases in the formation of human capital.

Empirical and theoretical studies employing a human capital theory framework suggest that measuring the relationship between public spending on education and economic growth may be less appropriate than measuring more direct relationships (Becker, 1993; Hojo, 2003). Increases in public higher educational spending are often intended to have a direct effect on access and affordability of higher education, thereby increasing the formation of human capital (Callahan, 2001; Hauptman, 2001; Heller, 2001). Further, human capital theory indicates that education increases productivity (Becker, 1993). Using a human capital theory orientation, Hojo (2003) found that education has a more direct effect on productivity than on economic growth. Hojo further concluded that increases in educational attainment indirectly affect economic growth through improvements in productivity.

Figure 2 is a model of the relationships between investment in higher education, human capital, productivity, and economic growth. These relationships, and other factors identified in the literature, are discussed in this chapter before models are developed to
Figure 2. Theoretically-Based Model of the Relationships between Investment in Higher Education, Human Capital, Productivity, and Economic Growth (Becker, 1993)
test the relationship between state spending on higher education and human capital formation and the relationship between human capital and economic benefits.

Productivity

Productivity is a measure of economic efficiency and is commonly used to demonstrate how effectively economic inputs are converted to economic outputs. Theoretical and empirical evidence support the claim that the formation of human capital raises productivity (Becker, 1993; Bishop, 1994; Black & Lynch, 1996; Denison, 1962; Denison, 1982; Jorgenson & Fraumeni, 1993; Mincer, 1974; Schultz, 1971) and that increases in productivity directly raise national income and other indicators of economic growth (BLS, 2004).

Productivity is calculated by constructing a ratio of economic outputs to inputs. Growth accounting, a set of economic theories used to explain economic growth, attributes growth in national income, or economic growth, to increases in the stock of physical capital, the availability of technology, and the productivity and size of the labor force (Barro, 1998; Denison, 1962). Research on the relationship between educational investment and economic growth has identified that the correct pairing of human capital and physical capital is imperative to economic growth (Becker, 1993; Benhabib & Spiegel, 1994). Physical capital refers to non-human assets made by humans and then used in production, such as machines and equipment (Checchi, 2006; Dess & Picken, 1999).

Increases in productivity are a significant source of increases in national income (BLS, 2004). A study conducted by the Organization for Economic Cooperation and Development (OECD) provides evidence of the strong relationship between productivity and economic growth in the United States. The OECD found that increases in productivity were a major cause of economic growth in the United States in the 1990s (Clarke, et al., 2001).

Productivity is enhanced by improvements in technology and human capital (Becker, 1993; Landau, 1988). While neoclassical economic theory posits that enhancements to production lead to more output under the same input of capital and labor, endogenous growth theory attempts to account for the technological advancements by incorporating these advancements into economic models (Romer, 1994; Smith, 1976).
For example, higher education is often credited with creating knowledge spillovers through research that results in improvements to productivity (Becker & Lewis, 1992; McMahon, 1992).

In addition to productivity’s relationship with economic growth and technology, productivity is also a central concept in human capital theory. The theory of human capital holds that education, or the formation of human capital, directly increases individual productivity (Becker, 1993; Mincer, 1974; Schultz, 1971). Support for this construct of human capital theory has been supplied by the research on human capital and productivity such as that conducted by Bishop (1994), Jorgenson and Fraumeni (1993), and Black and Lynch (1996).

Bishop (1994) studied employee and employer perceptions of productivity in relation to employer-provided training. Specifically, Bishop (1994) administered a survey to recipients of employer-provided training to determine the effect of the training on productivity. While he found that employer-provided training raises the productivity of employees by 16%, his study did not attempt to measure increases in productivity brought on by education in the form of schooling.

In attempting to examine the macroeconomic effects of education on productivity, Jorgenson and Fraumeni (1993) studied the lifelong economic value of labor market activities of workers with different education levels following World War II. The major finding of their study was that investment in human and nonhuman capital accounted for the largest part of economic growth in the period of study. They found that a doubling of the value of labor during the four decades studied corresponded to substantial growth in levels of educational attainment. For example, in 1949, the value of market labor activities for males with an eighth grade education or less was $308.8 billion while the value for males with a college degree was $336.4 billion. In constant dollars, the value for males with an eighth grade education or less in 1987 was just $54.3 billion and $744.9 billion for males with a college degree. Adding further to their conclusion that education, as an investment in human capital, was an important factor in economic growth, they also found that the value of labor produced by women, specifically, increased rapidly as educational attainment increased rapidly for women.
Black and Lynch (1996) also studied the impact of human capital investments on productivity and included measures that accounted for education and employer-provided training. They developed and implemented a survey that aimed to reduce error in measurements brought on by subjectivity in perceptions of productivity by including questions aimed at measuring productivity directly, such as the dollar value of sales, the book value of capital stock, and the cost of materials used in given production years. Measures of productivity were then compared with worker characteristics such as education level, training consumption, and management practices. Nearly 3000 private sector, for-profit employers were surveyed. Based on evidence from the survey, the authors concluded that human capital was an important determinate in productivity and that the average education level of those employed by the businesses surveyed had a positive and significant effect on productivity.

Human capital is not the only factor identified by the literature as contributing to increases in productivity and economic growth. In a cross-country, longitudinal study of determinants of economic growth, Barro (1997) found that factors such as better maintenance of the rule of law, smaller government consumption, longer life expectancy, lower fertility rates, improvements in the terms of trade, and lower inflation each had a significant impact on economic growth. These factors are denoted in the model illustrated in Figure 2 as other factors influencing economic growth. In addition to these factors, technological change is considered to be a major factor contributing to increases in productivity (Salter, 1960).

In total, human capital theory supports the claim that increases in the formation of human capital have a positive effect on productivity. Productivity may, in turn, have a positive effect on economic growth.

Income Inequality

In addition to productivity, the literature suggests that income inequality has a direct relationship to human capital and it, too, may be an intermediate factor in examining the relationship between human capital and economic growth. Moreover, a substantial body of literature exists on the relationship between income inequality and economic growth. This literature suggests that the relationship is complex and related to the relative development of an economy, the unit of analysis, and the duration of time.
studied. Unlike the relationship between human capital and productivity and the relationship between productivity and economic growth, the relationship between human capital and income inequality and the relationship between income inequality and economic growth are not clearly causal (Bishop et al., 1992; Checchi, 2001; Checchi, 2002; Mayer, 2001; Sylwester, 2002).

Income inequality refers to the distribution and dispersion of income across a population (Barro, 2000). Measures of income inequality are routinely used by economists to describe the distribution of wealth within a society. Across countries, specific measures of income inequality can be used to compare the distribution of income in one country to that of another. For example, Barro (1999) compared income inequality across many countries to determine the relationship that it had with economic growth. Within economies, measures of income inequality can be used to compare the distribution of income over time. For example, Weinberg (1996) examined changes in income inequality within the United States since World War II. Income inequality may also be studied across economies and over time, as Checchi (2003) did in examining the relationship between income inequality and access to education in 108 countries during a 35-year period. The following discussion examines income inequality in the United States, describes the relationship between human capital theory and income inequality, and examines the relationship between income inequality and economic growth.

**Income Inequality in the United States**

Since 1968, the United States has experienced a rise in income inequality (Weinberg, 1996) with the greatest change occurring since 1980. Income inequality rose by more than 22% from 1968 to 1994 when measured by the Gini coefficient, a widely used measure of income inequality. The United States Census Bureau reports that the direction of income inequality indicators changed in 1968 (Weinberg, 1996). From the end of World War II to 1968, the United States experienced a decrease in income inequality, as quantified by the Gini coefficient. This is to say that income initially became more equally distributed in post-war America. Then, from 1968 to 1980, the United States experienced modest or no growth in income inequality, while significant growth in income inequality occurred from 1980 to 2005, the most recent year for which data are available (DeNavas-Walt, Proctor, & Lee, 2006; U.S. Census Bureau, 2000).
Research identifies the widening wage gap between skilled and unskilled laborers as a major cause for the rise in income inequality since the late 1960s (Bradbury, 1996; Gottschalk & Danziger, 2005; US Census Bureau, 2000; Weinberg, 1996). To understand the relationship between wage and income, it is necessary to define each term. Income (I) is defined as the sum of earnings (E) and non-earned income (N) during the course of a year such that (Gottschalk & Danziger, 2005):

\[ I = E + N \]  
(1)

Earnings (E) are the product of wage rates (W) and hours (H) worked.

\[ E = W \cdot H \]  
(2)

Non-earned income has been defined by the United States Census Bureau to include unemployment compensation, workers’ compensation, social security, supplemental security income, public assistance, veterans’ payments, survivor benefits, disability benefits, pension or retirement income, interest, dividends, rents, royalties, and estates and trusts, educational assistance, alimony, child support, financial assistance from outside of the household, and other income (United States Census Bureau, 2004).

Studies of income inequality in the United States have resulted in the conclusion that income inequality is largely the result of wage inequality (Gottschalk & Danziger, 2005). Inequality of wages in the United States is, in large part, the result of significantly higher wages paid to college graduates when compared to non-college graduates (Gottschalk & Danziger, 2005; McNeil, 1998; Welch, 1998). Economic demand for college-educated workers in the United States has grown relative to supply while the opposite is true for those with less education (Bradbury, 1996; US Census Bureau, 2000). Wages have responded to the economic law of supply and demand by increasing for those workers who have attained higher levels of education and decreasing for those workers who have lower levels of education and therefore lack the sort of education demanded by the market place.

**Income Inequality and Human Capital Theory**

Human capital theory explains that the demand for workers with higher levels of education is based on productivity (Becker, 1993). Workers with more education or better training are more productive than workers with less education and poor training (Jorgenson & Fraumeni, 1993). Increases in productivity that result from participation in
education permit those who possess greater amounts of education to command more money when trading their labor in the marketplace (Becker, 1993). The findings of Bishop (1994), Jorgenson and Fraumeni (1993), and Black and Lynch (1996) support the relationship between human capital and productivity; the findings of Devroye and Freeman (2001) provide evidence of a relationship between earnings and education. Devroye and Freeman (2001) used results from the International Adult Literacy Survey as a proxy for skills and correlated the results with personal income. They studied 12 developed countries and found that skills and income showed the strongest correlation in the United States. Such a finding appears to indicate that evidence of human capital theory is strongest in the United States.

Human capital theory is not without its detractors. The theory of signaling and screening asserts that employers hire college graduates and pay them higher wages based on the signal that graduates emit, rather than the increases in productivity produced by a college education as explained by human capital theory (Arrow, 1973; Spence, 1973; Stiglitz, 1975). Employers use the college degree as a screening mechanism to hire workers that may be intellectually or otherwise predisposed to be more productive (Arrow, 1973; Spence, 1973; Stiglitz, 1975). Early proponents of the theory of signaling and screening claimed that a college education does little to contribute to the productivity of its recipients.

But the theory of signaling and screening has been softened in recent years such that many studies that use it as framework now also acknowledge the effects of human capital on productivity (Brown & Sessions 2004). A blending of human capital theory and the theory of signaling and screening, called weak screening, finds that education both signals and improves productivity. In a meta-analysis of the literature concerning weak screening, Brown and Sessions (2004) identify the findings of Wolpin (1977), Riley (1979), Shah (1985), Brown and Sessions (1999), Katz and Ziderman (1980) and Grubb (1993) as supportive of the weak screening hypothesis. Grubb (1993) used the National Longitudinal Survey of the class of 1972 to examine differences in earnings for people in salaried occupations who are assumed to be screened versus people in self-employed positions that are unscreened. Grubb’s findings indicated that while high school degrees and vocational associate degrees were used as screens, the baccalaureate degree did not
operate as a signal since self-employed, or unscreened workers, earned substantially more
than screened positions.

*Income Inequality and Economic Growth*

Evidence from studies that use a human capital theory framework supports the finding that income inequality is largely the result of differences in educational attainment and training. Studies employing a human capital theory framework also provide evidence of a relationship between income inequality and economic growth. These studies appear to indicate that a positive relationship exists between income inequality and growth across wealthier nations at a given point in time (Barro, 1999, 2000) while a negative relationship exists among poorer countries and at the sub-national level across time (Barro 1999, 2000; Hsing, 2005; Li, Squire, & Zou, 1998).

When examining the relationship between income inequality and economic growth using whole countries as the unit of analysis, Barro (1999, 2000) found a positive relationship for wealthy countries and a negative relationship for poor countries. That is, Barro (1999) confirms previous findings that higher income inequality tends to slow growth in poorer countries and promote growth in wealthier countries. According to the demarcation of poor and wealthy countries used by Barro (1999)—per capita annual income below $2000 for poor countries and above $2000 for wealthy countries—and Barro (2000)—per capita annual income below $2070 for poor countries and above $2070 for wealthy countries—the United States falls in the latter category in both studies.

The changing direction of the relationship between economic growth and income inequality is, according to Barro (1999, 2000), confirmation of the Nobel Prize winning work of Simon Kuznets. Kuznets (1955) identified the existence of an inverted U-shaped curve to describe a process by which income inequality first increases and then decreases as economies develop. The curve appears on a graph in which economic development over time is measured on the horizontal axis and income inequality is measured on the vertical axis. Using cross-sectional data, Kuznets (1955) found that initially income inequality rose in the early stages of economic development and then fell in the later stages of economic development. Figure 3 displays the Kuznets curve. The left half of the Kuznets curve is characterized by a reliance on highly concentrated physical capital while
Figure 3. Kuznets (1955) curve
the right half of the curve gives way to broadly dispersed human capital (Barro, 2000).

Barro (1999) notes that the shape of the Kuznets curve is attributable to changes in economies. Kuznets (1955) and Robinson (1976) describe a single change from rural, agrarian to urban, industrial economies. Modern interpretations of the Kuznets curve attribute its shape to changes in technology (Barro, 2000). According to this perspective, multiple curves are possible as economies move from old to new technology (Barro, 2000). As such, an individual curve is the result of a few members of the economy schooled, i.e., forming human capital, in the technology initially benefiting from an economic change, followed by many benefiting as they too are schooled in the latest technology.

As noted in the research of Barro (1999, 2000), a negative relationship between income inequality and economic growth appears to exist in poorer countries. Researchers cite political and social unrest as contributing factors in the negative relationship (Alesina & Perotti, 1995; Barro, 2000; Benabou, 1997). There are two major explanations for the negative relationship between sociopolitical unrest and economic growth. First, the threat of civil unrest produces uncertainty and may discourage investment (Alesina & Perotti, 1996; Barro, 2000; Benabou, 1997). Second, poverty resulting from inequality may encourage participation in crime and other antisocial behavior thereby creating a drag on the economy given that criminals are devoting resources to activity that negatively, rather than positively, impacts the economy (Barro, 2000). Posner (2001) investigates this possibility in the context of the United States and finds that political and social unrest are unlikely to result from increased levels of income inequality experienced in the United States, given that most income groups are experiencing increases in income even if the increase is smaller than that received by the wealthiest in the population.

Posner’s (2001) study exposes two noteworthy differences in research concerned with income inequality: the level of analysis and the relative development of economies. Benabou (1997) and Alesina and Perotti (1996) used the country as the level of analysis and were most concerned with the impact of income inequality in developing countries. A study conducted by Hsing (2005) used states in the United States as the level of analysis, thereby sampling from highly developed economies. Studies conducted by
Barro (1999, 2000) and Li et al. (1998) may shed additional light on the importance of the relative development of economies and the unit of analysis.

While the work of Kuznets might propose otherwise, the work of Hsing (2005) suggests that rising income inequality in the United States slows economic growth. Hsing’s (2005) study was conducted in response to findings by Panizza (2002), who found that a negative relationship existed between income inequality and economic growth in the United States. While Panizza’s (2002) study found that the negative relationship was not robust and that differences in the method used to measure inequality resulted in large differences in the relationship between income inequality and economic growth, Hsing’s (2005) study resulted in a robust relationship between inequality and growth.

Hsing (2005) studied income inequality and economic growth from 1967 to 2001. In this study, Hsing used a stock measure of human capital in operationalizing human capital as the percentage of the population that had obtained a four-year degree. He found that growth in employment, investment spending, patents granted, and human capital all contribute to economic growth in the United States, while increases in income inequality were harmful to economic growth in the United States. The negative relationship between income inequality and economic growth identified by Hsing was consistent across multiple measures of income inequality, and despite the difference in the direction of the relationship, his findings were not altogether incompatible with the findings of Kuznets (1955).

Two explanations are found in the literature to support the findings of Hsing (2005) while not altogether dismissing the work of Kuznets (1955). First, the modern interpretation of the Kuznets curve may suggest that a change in technology has occurred during the period studied by Hsing (2005), thereby placing the United States on the upward slope of a Kuznets curve. Second, it is possible that the Kuznets curve is not appropriate for the longitudinal study of individual countries. Li, Squire, and Zou (1998) found that the inverted U-shape of the curve credited to Kuznets (1955) is more appropriate to cross-sectional data from many countries rather than time series data from an individual country. Hsing’s (2005) analyzed longitudinal data from an individual country.
The findings of Hsing (2005) reinforce the existence of a relationship between economic growth and income inequality. These studies identify that income inequality may diminish in the later stages of economic growth or a technological change. At the same time, increases in income inequality may retard growth, even in highly developed economies such as the United States (Hsing, 2005). This appears to indicate a level of mutual causation in the relationship between income inequality and economic growth. In describing the relationship between economic growth, income inequality, and human capital, Hsing (2005) identifies the importance of increasing human capital as defined by the level of baccalaureate degree recipients, to sustaining economic growth.

In summary, evidence exists to support a relationship between human capital and income inequality as well as a relationship between income inequality and economic growth. The nature and direction of the relationship between income inequality and economic growth is subject to debate, though evidence appears to indicate that the findings of Kuznets (1955) are sensitive to the sample type and duration. The relationship between human capital and income inequality is tied to the notion that differences in income are largely the result of differences in wages, while differences in wages are largely the result of differences in education.

**Relationships between Factors**

The literature suggests that at least two economic factors are directly related to human capital while economic growth is indirectly related to human capital. The factors that are directly related to human capital are productivity and income inequality. In addition, the literature suggests that relationships exist among productivity, income inequality, human capital, and state spending on higher education.

As noted previously, theoretical and empirical evidence support a relationship between productivity and education, income inequality and education, as well as productivity and income inequality. The theoretical evidence emanates from human capital theory, which claims that increases in education result in increases in productivity (Becker, 1993; Mincer, 1974; Schultz, 1971). Users of the theory find that differences in education result in differences in productivity such that those with more education are more productive than those with less education (Black & Lynch, 1996; Jorgenson & Fraumeni, 1993). Continuing, human capital theory explains why higher wages are
afforded to those with more education in that differences in productivity that arise from education make the labor of educated workers more valuable than less educated workers (Becker, 1993; Hojo, 2003; Jorgenson & Fraumeni, 1993). That is to say, because education raises productivity (Becker, 1993; Denison, 1985) and because higher productivity is preferred to lower productivity in the marketplace (Smith, 1976), those who are more productive are able to sell their labor for higher rates than those who are less productive.

*Public Spending on Education*

The relationship between public (i.e., government) spending on education and income inequality has been examined in a number of research studies, most of which have focused on primary, secondary, or all levels of educational spending, rather than spending on higher education specifically. While cross-sectional studies have found that public educational spending and income inequality are positively related, studies that employed a longitudinal methodology resulted in findings that indicate government spending on education and income inequality are negatively related.

Despite the fact that previous studies on the relationship between government spending on education and income inequality have not focused on higher education specifically, such studies reveal that the use of a longitudinal versus a cross-sectional methodology plays a key role in the direction of the relationship. Sylwester (2002) found that countries that devote a greater percentage of gross domestic product to public education have lower income inequality in subsequent years, signifying a negative relationship between education spending and income inequality. Mayer (2001) also identified a negative relationship between state spending on education and income inequality, and concluded that higher levels of educational spending resulted in decreased levels of inequality in subsequent years. Both Mayer (2001) and Sylwester (2002) used longitudinal data in their analysis of the relationship.

In studying more than 90 countries, Checchi (2000, 2001) found that government expenditures on education were positively associated with income inequality in the most developed countries—including the United States. In the United States, specifically, Bishop et al. (1992) found that higher per capita educational expenditures were
associated with states that have higher income inequality, though they did not determine if the relationship was causal.

While Bishop et al. (1992), Checchi (2000), and Sylwester (2002) each examined educational spending at all levels and Mayer (2001) was primarily concerned with primary and secondary education spending, little research exists on the relationship between state level higher education spending and income inequality. Greenways and Hayes (2004) reinforced the need to study the relationship between spending on higher education and income inequality by noting that developed countries and developing countries are distinguished by the type education offered. That is, the critical factor in the distribution of income and the accumulation of wealth may be the level of education upon which money is spent and not simply education spending in general. Table 1 summarizes studies of the relationship between spending on education and income inequality. The summary of these findings confirms the conclusion of Greenways and Hayes (2004) in that none of these studies examines spending on higher education specifically. In addition, Table 1 identified that studies that accounted for the lag time between investment in education and a change in income inequality each found a negative relationship between spending on education and income inequality.

In addition to relationships between public spending on education and income inequality, previous studies have examined the relationship between public spending on education and the formation of human capital. These studies have identified a positive relationship between public spending on education and the formation of human capital. Checchi (2003) studied the relationship between educational enrollment, which is a flow measure of human capital, and public spending on education. He found that the total amount of public resources expended on education had a positive effect on higher education enrollment. In addition, he found that increases in spending on secondary education had a positive effect on higher education enrollment.
Table 1

*Studies Examining Government Spending on Education and Income Inequality*

<table>
<thead>
<tr>
<th>Study</th>
<th>Relationship</th>
<th>Unit of analysis</th>
<th>Education level</th>
<th>Time lapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sylwester, 2002</td>
<td>−</td>
<td>Country</td>
<td>Non-specific</td>
<td>Yes</td>
</tr>
<tr>
<td>Checchi, 2000, 2001</td>
<td>+</td>
<td>Developed country</td>
<td>Non-specific</td>
<td>No</td>
</tr>
<tr>
<td>Bishop et. al, 1992</td>
<td>+</td>
<td>States</td>
<td>Non-specific</td>
<td>No</td>
</tr>
<tr>
<td>Mayer, 2001</td>
<td>−</td>
<td>States</td>
<td>Primary &amp; Secondary</td>
<td>Yes</td>
</tr>
</tbody>
</table>
A study conducted by Mayer (2001) examined the relationship between educational attainment, income inequality, and state spending for education. Her study found that greater spending on education was associated with higher college enrollment and graduation. She also found evidence that states with greater income inequality increased educational attainment by spending more on education.

Obstacles to Studying Economic Benefits at the State Level

This section includes a theoretically-based model of the relationship between state spending on higher education and the economic benefits of higher education followed by a discussion of the methodological obstacles to testing such a relationship. The chapter concludes with an outline of two practical models for examining the relationship: one examining state spending on higher education and the formation of human capital and another examining stock measures of human capital and measures of economic benefit.

Theoretically-Based Model

Based on a review of the literature, a theoretical model of the predicted relationship between state spending on higher education, human capital, productivity, income inequality, and economic growth was developed. The theoretical model postulates that human capital, productivity, and income inequality each factor into the relationship between educational spending and economic growth. Specifically, the model postulates that educational spending affects the formation of human capital which affects productivity and income inequality which in turn affect economic growth.

The model also accounts for the possibility that the relationship between human capital and income inequality, productivity and income inequality, and economic growth and income inequality may, in fact, be reciprocal and, therefore have elements of mutual causation. The remaining relationships are theorized to have single direction causation such that an increase in educational spending causes an increase in human capital (Becker, 1993), an increase in the formation of human capital causes an increase in productivity (Becker, 1993), and an increase in economic growth. Figure 4 represents this theoretical model of the relationship between these factors.

Methodological Obstacles
Figure 4. Theoretically Based Model of the Relationship between Higher Education Spending and Economic Growth
The methodologies used in state-level studies have precluded the production of evidence supporting or refuting the relationship between spending and benefit of the transmission and the dissemination of knowledge through higher education for three main reasons: (a) research has focused on all levels of education, rather than higher education specifically; (b) research has failed to account for the interstate migration of recipients of higher education and lag time between investment and economic gains (Gittell & Sedgley, 2000; Quan & Beck, 1987; Strathman, 1994); and (c) research has focused on the relationship between state spending and economic growth rather than the intermediate and direct relationships between spending and the formation of human capital, human capital and productivity, and productivity and economic growth (Becker, 1993; Checchi, 2003; Denison, 1985; Hojo, 2003; Mincer, 1974; Schultz, 1971).

The model depicted in Figure 4 addresses two of the methodological obstacles previously outlined in that the model is limited to spending on higher education and accounts for a direct relationship between human capital and productivity as well as the relationships between human capital and income inequality and productivity and income inequality. However, the model does not explicitly address the issues of interstate migration or lag time between spending on higher education and economic benefits. As such, the model described in Figure 4 becomes impractical when attempts are made to apply the model at the state level. Interstate migration of degree recipients that allows some states to act as free-riders (Gittell & Sedgley, 2000; Quan & Beck, 1987; Strathman, 1994), and the lag time between state investment in higher education and increases in economic productivity on the part of degree recipients (Aschauer, 1992) severely limit the practical testing of the model illustrated in Figure 4.

Studies have identified that interstate migration and lag time between spending on higher education and the realization of economic benefits reduce the ability of researchers to adequately correlate state spending on higher education and the economic output of graduates within states (Aschauer, 1992; Gittell & Sedgley, 2000). Researchers caution that it is very difficult to reach conclusions on the relationship between state spending and economic growth given that states benefit from the spending of other states, allowing some states to act as free-riders (Gittell & Sedgley, 2000; Quan & Beck, 1987; Strathman, 1994). For example, a state may expend money to provide an education to
students who leave the state after obtaining a degree. In addition, Aschauer found that the
time lag between government spending, the actual education of the workforce, and the
eventual impact on productivity is “long and varied enough to sever any
contemporaneous link between public expenditures on [education] and private sector
productivity” (1992, p. 89).

To understand the limitations of the model in consideration of lag time and
interstate migration, it is necessary to provide some information on how estimates of the
economic contribution of education are made and review how human capital is typically
measured. An annotated bibliography of human capital identified the following
categories of human capital studies: residual analysis studies, returns to investment
studies, and simple correlation and regression studies (Bowen, 1964; Sweetland, 1996).
Residual analysis studies and returns to investment studies have been deemed effective
methods for calculating human capital, but neither produce measures of human capital
that are quantifiable in terms of education level. Simple correlation and regression studies
are often used to estimate the economic contribution of education by examining the
relationship between an educational index (i.e., a measure of human capital) and an
economic index (Bowen, 1964; Sweetland, 1996). Stock measures of human capital, such
as the number of people in a population with a college degree, may not be appropriately
correlated or regressed with state spending on higher education given that interstate
migration and variations in the lag time between investment and productivity reduce the
meaningfulness of the correlation (Aschauer, 1992; Gittell & Sedgley, 2000). The
complications brought on by interstate migration and lag time are possible reasons why
Vedder (2004a) found no relationship between state spending on higher education and the
stock of human capital (i.e., the percentage of the population with a college degree) as he
failed to account for these factors in his study. To overcome this impediment of
measuring the relationship between human capital and economic benefit, flow measures
of human capital, such as the number of people participating in higher education, may be
used to account for the formation of human capital.

Although flow measures of human capital may be useful in measuring the
relationship between state spending on higher education and the formation of human
capital in that flow measures overcome the obstacles presented by interstate migration
and lag time, such measures are inappropriate for testing the relationship between human capital and state-level economic productivity. Flow measures of human capital, by definition, do not account for existing human capital that may contribute to state-level economic productivity (McNamara, et al. 1988; Psacharopoulos & Patrinos, 2004). That is, those enrolled in higher education are unlikely to participate fully in the workforce, and therefore boost economic productivity.

Practical Models

Given these constraints, the model outlined in Figure 4 cannot be tested using a single variable that accounts for human capital. Instead, the model may be tested in two parts. The first of two models may be used to test the relationship between state spending on higher education and the formation of human capital using a flow measure of human capital, such as the percentage of the state population currently enrolled in higher education. An illustration of this model is provided in Figure 5.

The model illustrated in Figure 5 may be tested by examining the concurrent relationship between state spending on higher education and the formation of human capital such that current spending levels are correlated with current measures of flow human capital. In addition, the model illustrated in Figure 5 may be tested by examining the extent to which changes in state spending on higher education predict future changes in the formation of human capital, as is suggested by Sylwester (2002) and Mayer (2001).

A second model can be constructed to test the relationship between human capital and economic benefit using stock measures of human capital. An illustration of this model is provided in Figure 6. Traditional stock measures of human capital include the percentage of the population over age 25 with a college degree and the average educational attainment of a population (Psacharopoulos & Patrinos, 2004).

To examine the relationship between state spending on higher education and public economic benefits of higher education, and in view of the methodological constraints identified by previous examinations of this topic, a study will be undertaken in two phases. The first phase will test the extent to which the concurrent relationship and changes in state spending on higher education predict the formation of human capital as depicted in Figure 5, using a measure of human capital that is not substantially affected by interstate migration of degree recipients and lag time between educational investment.
Figure 5.
Theoretically Based Model of the Relationship between Higher Education Spending and the Formation of Human Capital
Figure 6. Theoretically Based Model of the Relationship between Human Capital and Economic Growth
of the state and economic productivity of the recipient. The second phase will test the extent to which changes in state spending on higher education predict the formation of human capital in states grouped by income inequality and changes in productivity. The second phase will capitalize on the relationships identified in Figure 6 by deliberately sampling states that demonstrate extreme cases of productivity and income inequality.

The next chapter provides a description of the methodology employed in this study to answer the research questions posed in chapter one. The two phases of the study are then presented as research articles in chapters four and five.
CHAPTER 3
METHODOLOGY

To answer the research questions posed in Chapter 1, this study will be undertaken in two phases. The result of these two phases will be presented in two research articles for publication. This chapter describes the method employed in the two phases of this study. A description of the sampling procedure, the data sources and procedures used to collect data, and the procedures used to analyze the data follow.

Sampling Procedure

The unit of analysis for this study is the state. The total population from which this study may draw includes the 50 United States. The first phase of the study begins with an analysis of all 50 states and proceeds to segregate the total number of states by changes in enrollment rates, such that the 50 states are divided into three nearly equal groups.

The second phase of the study employs extreme case sampling. Extreme case sampling is a form of purposeful sampling that selects cases based extreme manifestations of factors identified by the literature (Flyvbjerg, 2006; Patton, 1990). All 50 states were evaluated to identify states that demonstrated extreme instances of a set of factors predicted by the literature to influence the relationship between the formation of human capital and economic growth. Extremes in income inequality and changes in productivity are used to select states that are examined in this study.

The value that a sample of a few extreme cases holds over an analysis of all states is based on the idea that the extremes in factors may be useful in magnifying the effects of the factors while affording the ability to probe into the diversity of the states. An analysis of all states could result in a homogenized description of the relationship between the factors such that the positive effects of a factor in one state are counteracted by the negative effects of the same factor in another state, thereby trading specificity of results for an unnecessary amount of generalizability. The use of extreme cases may be used to highlight important differences between states based on the selection factors, thereby permitting for greater use of results.

To achieve a sufficient number of observations, states were ordered by income inequality and changes in productivity and then divided into quintiles containing 10 states.
each. The highest and lowest quintile for each group was then analyzed. The ordering of states was based on commonly recognized measures of income inequality and productivity using data obtained from national sources.

Data Sources and Collection Procedures

The primary sources of data for this study consist of existing federal and national data collections. Data were collected for those states included in the sample from the years 1980, the first year in which data are available for all factors, to 2005, the most current year in which data is available for all factors. A description of the variables, the data sources, the individual data items that served as proxies for the variables, and the data availability follows for each of the variables. Table 2 provides an overview of the variable, data items, data sources, and data availability.

Human Capital

State higher education enrollment rates are used as a measure of human capital for this study. Specifically, enrollment rates are calculated by dividing the total state enrollment in higher education by the state population age 18-24. The literature supports the use of higher education enrollments as a measure of human capital (Heller, 1996, 1999; Psacharopoulos & Patrinos, 2004). This measure is not substantially affected by interstate migration of degree recipients and lag time between educational investment of the state and economic production of the recipients. The specific method for calculating enrollment rates here was used by Heller (1996), who noted that such a method assumes that the denominator represents the traditional but not the entire college-going population and acknowledges that the numerator includes students who fall outside of that age range. At the same time, this measure was a limitation of the study in that 18- to 24-year olds are not only college going population.

Data source. The National Center for Education Statistics’ Integrated Postsecondary Educational Data System (IPEDS): Enrollment Survey is an annual survey of institutions of higher education. IPEDS is a comprehensive system of surveys designed to collect institution-level data on enrollments, program completions, faculty, staff, and finances from all primary providers of postsecondary education. Data on estimates of state populations age 18 to 24 were collected from the U.S. Census Bureau’s Population Estimation Program which provides such state-level estimates annually.
### Summary of Variables, and Associated Item Descriptions, Data Sources, and Availability

<table>
<thead>
<tr>
<th>Variable</th>
<th>Item: Data Description</th>
<th>Source/ Data Set</th>
<th>Data Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Higher education enrollment rates are calculated using the following formula: total higher education enrollment divided by state population age 18 to 24.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Appropriations per capita are calculated using the following formula: gross state and local tax and non-tax fund support appropriations / state population estimation and adjusted for 2006 constant dollars.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Investment</td>
<td>State and local appropriations for general operating expenses of public higher education less research, agriculture, and medical expenditures per public FTE:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Appropriations per public FTE are calculated using the following formula: (state appropriation + local appropriation - research, agriculture, and medical appropriation) / FTE and adjusted for the system’s enrollment mix, state cost of living, and 2006 constant dollars.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The variable is calculated by dividing the total state spending on grant aid by the state total of full time equivalent students.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Private investment | Average in-state tuition and required fees for full-time undergraduates at public four-year institutions:  
The variable is calculated by adding the tuition and required fees for each public four-year institution in the state and dividing by the number of institutions. | National Center for Education Statistics. *Integrated Postsecondary Educational Data System: Institutional Characteristics/Admissions/Student Charges Survey*. Washington, D.C. | Data are available for all 50 states for years 1967-2005, excluding 1999. |
|-------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Private investment | Average in-state tuition and required fees for full-time undergraduates at public two-year institutions:  
The variable is calculated by adding the tuition and required fees for each public two-year institution in the state and dividing by the number of institutions. |  |  |
| Private investment | Average in-state tuition and required fees for full-time undergraduates at private, non-profit four-year institutions:  
The variable is calculated by adding the tuition and required fees for each private, not-for-profit four-year institution in the state and dividing by the number of institutions. |  |  |
| Economic Conditions | State unemployment rates:  
The National Center for Educational Statistics (NCES) has collected data on enrollment since 1967. Prior to 1996, the universe of postsecondary institutions surveyed included only those institutions recognized by the Secretary of the U.S. Department of Education. Since 1996, the survey has been administered to the postsecondary institutional universe on the basis of the degree-granting status as well as eligibility for Title IV federal financial aid. The U.S. Census Bureau’s Population Estimates Program publishes total resident population estimates and demographic, by state and by age ranges, each year.

Data description. The data item obtained from NCES includes the number of students, by state, enrolled in courses that are creditable toward a degree, diploma, certificate, or other formal award, or are part of a vocational or occupational program including any students enrolled in off-campus centers. Also included are high school students enrolled in postsecondary education courses creditable toward completion of a program (i.e. dual enrollment). This number is divided by the estimated state population, obtained from the U.S. Census Bureau, age 18 to 24 for the year of the survey.

Data availability. Data are available for all 50 states annually from 1967 to 2005, except in years 1999 and 2001. IPEDS enrollment data were not available in year 1999. State population data, broken out by the specified age range, were not available from the U.S. Census in year 2001. To be consistent with state spending data collected from the State Higher Education Executive Officers, these data were collected from each state included in the sample, from 1980 to 2005, excluding 1999 and 2001.

Public Spending: State Appropriations for Higher Education

State and local expenditures for the general operation of public and independent institutions of higher education per capita and state and local appropriations for general operating expenses of public higher education less research, agriculture, and medical expenditures per public full time equivalent student serve as two measures of state spending on higher education and as proxies for public spending on higher education (Gianneschi & Yanagiura, 2007). These two data items attempt to measure the state and local spending on higher education and control for, in their respective ways, the states’ populations and the full time equivalent enrollment at public institutions. These measures attempt to address state spending on higher education from both tax and non-tax sources.
Data source. State Higher Education Executive Officers (SHEEO) conducts an annual survey, the State Higher Education Finance (SHEF), of state higher education finance officers on multiple aspects of state-level finance of higher education.

Data description. The two data items sought from the SHEF survey included state and local expenditures for the general operation of public and independent institution of higher education per capita and state and local appropriations for general operating expenses of public higher education less research, agriculture, and medical expenditures per public full time equivalent student. The data for both items were calculated by SHEEO. State and local expenditures for the general operation of public and independent institution of higher education per capita includes all tax and non-tax support from state and local government and is inclusive of spending on research, agriculture and medical education. The data item was calculated by dividing state and local expenditures, as defined here, by the total population of the state.

State and local appropriations for general operating expenses of public higher education per public full time equivalent student includes only spending on public institutions and is exclusive of spending on research, agriculture, and medical education. The data item is calculated by dividing state and local expenditures, as defined here, by the number of full time equivalent students enrolled in public institutions of higher education.

Data availability. Data are available for all 50 states for years 1980-2006. To be consistent with state spending data collected from the US Census and IPEDS, these data were collected from each state included in the sample, from 1980 to 2005, excluding 1999 and 2001.

Public Spending on Student Financial Aid

Estimated undergraduate grant dollars per undergraduate enrollment measures a special aspect of state spending on higher education: financial aid to students (Heller, 2001; Hendel et al. 2005). Generally, this measure serves as a proxy for public spending on higher education (Gianneschi & Yanagiura, 2007; Heller, 1997). The data item attempts to measure states’ spending on grant aid while controlling for states’ enrollment in higher education. The literature identifies that factors driving enrollment demand
include the availability of financial aid (Boilard, et al., 2005; Braunstein, McGrath, & Pescatrice, 1999; National Center for Educational Statistics, 2005b; St. John, 1990).

Data source. The National Association of State Student Grant & Aid Programs (NASSGAP) conducts a survey annually of state agencies responsible for the administration of state appropriated student financial aid in the interest of gathering information on state-funded, postsecondary student financial aid by program type and amount awarded. The survey results in data that include the estimated undergraduate grant dollars per undergraduate enrollment, by state.

Data description. The data item sought from the NASSGAP survey is the estimated undergraduate grant dollars per undergraduate enrollment, by state. The variable is calculated by NASSGAP and is derived by dividing NASSGAP data on the total amount of state grant dollars expended by National Center for Educational Statistics data on the number of full time equivalent students by state. NASSGAP defines grant aid to include grants, scholarships and other such gift aid administered by the state.

Data availability. Data were available for all 50 states annually from 1969 to 2005. To be consistent with state spending data collected from the State Higher Education Executive Officers, these data were collected from each state included in the sample, from 1980 to 2005, excluding 1999 and 2001.

Private Spending on Higher Education

Average in-state tuition and required fees for full-time undergraduates at public four-year; public two-year; and private, non-profit four-year institutions measure the tuition and fees associated with different types of institutions within each state sampled. This measure serves as a proxy for private spending on or investment in higher education (Heller, 1997; Leslie & Brinkman, 1988). The literature identifies that factors driving enrollment demand include the price of student tuition (Boilard, et al., 2005; National Center for Educational Statistics, 2005b).

Data source. The National Center for Educational Statistics collects data annually through IPEDS. The Institutional Characteristics/Admissions/Student Charges Survey within IPEDS requires all institutions receiving federal funding to provide data that includes the average in-state tuition for full-time undergraduates, and the in-state required fees for undergraduates.
Data description. The information sought from IPEDS included average in-state tuition and required fees for full-time undergraduates at public four-year; public two-year; and private, non-profit four-year institutions. The specific IPEDS variables sought included the amount of money charged per academic year to full-time, undergraduate students meeting the state’s or institution’s residency requirement for instruction (IPEDS variable: TUITION2) and for required items not covered by tuition (IPEDS variable: FEE2). For the purposes of collecting these data, IPEDS defined: undergraduate as a student enrolled in a 4- or 5-year bachelor's degree program, an associate's degree program, or a vocational or technical program below the baccalaureate; a full-time undergraduate as a student enrolled for 12 or more semester credits, or 12 or more quarter credits, or 24 or more contact hours a week each term; and, an academic year as the period of time generally extending from September to June, usually equated to 2 semesters or trimesters, 3 quarters, or the period covered by a 4-1-4 plan (NCES, 2007).

Within IPEDS, institutions in each state may be sorted by institutional control and highest degree offered. The IPEDS variable name for the control of the institution is CONTROL and includes three possible outcomes: public; private, not-for-profit; and private, for-profit. IPEDS defines public institution as one “whose programs and activities are operated by publicly elected or appointed school officials and which is supported primarily by public funds”; a private, not-for-profit institution as one “in which the individual(s) or agency in control receives no compensation, other than wages, rent, or other expenses for the assumption of risk”; and a private, for-profit as one “in which the individual(s) or agency in control receives compensation other than wages, rent, or other expenses for the assumption of risk” (NCES, 2007). The IPEDS variable name for the highest degree offered is HLOFFER and includes nine categories based on the highest level of offering. Institutions that offer at least an associates degree, but less than a baccalaureate degree, are classified as two-year institutions. Institutions that offer at least a baccalaureate degree are classified as four-year institutions.

Tuition and fee data were divided into three variables based on institutional control and highest degree offered. Tuition and fees at publicly controlled institutions offering at least a baccalaureate degree was the first of the three variables aimed at measuring the private investment in higher education. Tuition and fees at privately
controlled, not-for-profit institutions offering at least a baccalaureate degree was the second of the three variables. And tuition and fees at publicly controlled institutions offering at least an associate degree was the third of the three variables. For each of the three variables only tuition and fees for those colleges and universities meeting the definition of institutional control and highest degree offered was used.

Data for the variables were constructed from IPEDS variables TUITION2 and FEE2 by adding the values for these variables for the population of institutions of the specified control and highest degree offered and then dividing this value by the number of institutions of the specified control and highest degree offered in each state sampled.

**Data availability.** Data were available for all 50 states from 1967 to 2005. To be consistent with state spending data collected from the State Higher Education Executive Officers, these data were collected from each state included in the sample, from 1980 to 2005, excluding 1999 and 2001.

*Economic Conditions: Unemployment Rate*

State unemployment rates measure the number of people in the labor force actively looking for employment but unable to find it. This measure serves as a proxy for the attractiveness of alternative options to higher education in that a lower unemployment rate signals increased attractiveness of alternatives to higher education (Mattila, 1982; Macunovich, 1997). The literature identifies that factors driving enrollment demand include the availability and attractiveness of alternative options to education such as entering the workforce (Heller, 1996; Macunovich, 1997; National Center for Educational Statistics, 2005b).

**Data source.** The U.S. Bureau of Labor Statistics provides the *Local Area Unemployment Statistics* (LAUS) program. The LAUS program produces monthly unemployment estimates for states.

**Data description.** The U.S. Bureau of Labor Statistics LAUS analyzes data collected through the U.S. Census Bureau’s Current Population Survey (CPS) resulting in calculations of monthly unemployment rates for states. State unemployment rate is the percentage of the state’s civilian labor force actively looking for employment but unable to find it. The CPS is a monthly survey of households conducted by the Census Bureau for the Bureau of Labor Statistics that has been conducted for more than 50 years. It
provides a comprehensive body of data on the labor force, employment, unemployment, and persons not in the labor force. The universe consists of all persons in the civilian, non-institutional population of the United States living in households. The CPS does not provide monthly unemployment rates for states; instead it provides such information annually. However, LAUS does provide such data. The probability sample selected to represent the universe consisted of approximately 55,000 households in October, 2005.

Data availability. Data were available for all 50 states from 1976 to 2007. To be consistent with state spending data collected from the State Higher Education Executive Officers, these data were collected from each state included in the sample, from 1980 to 2005, excluding 1999 and 2001.

Data Analysis

Determining causation in research requires an experimental design (Thompson, 2000). Prior to establishing cause and effect between two variables, it is necessary to demonstrate that there is a relationship between the variables (Trochim, 2001). Previous studies have identified theoretical evidence supporting a causal relationship between government spending on education generally and the formation of human capital (Becker & Lewis, 1992; Carpentier, 2006; Checchi, 2003; Keller, 2006; Mayer, 2001; Sylwester, 2002; Webber, 2002). Yet, there is limited research available that addresses the relationship between state spending on higher education specifically and the formation of human capital (Vedder, 2004a). Data collected from the federal and national sources summarized in Table 2 were analyzed in an effort to provide additional information on the relationship between state spending on higher education and the formation of human capital. To this end, the analyses performed in phase 1 and phase 2 of this research answer specific research questions posed in Chapter 1. The following is a description of the research questions addressed, the specific statistical procedures employed, and the variables used for both phases.

Phase 1

The first phase tests the concurrent and longitudinal relationship between state spending on higher education and the state formation of human capital using a measure of human capital that is not substantially affected by interstate migration of degree recipients and lag time between educational investment of the state and economic
productivity of the recipient. In doing so, the first phase of the research addressed the question 1: to what extent does state spending on higher education predict the formation of human capital?; question 2: to what extent do changes in state spending on higher education predict changes in the formation of human capital?; and question 2a: to what extent does the predictive value of state higher education spending on the formation of human capital vary by changes in enrollment rate? This research also contributed to answering research question 3 stated in Chapter 1: what factors are useful in explaining the relationship between state spending on higher education and the formation of human capital?

The relationship between state spending on higher education and the formation of human capital was tested by using a time-series multiple regression procedures on independent variables, summarized in Table 2, (p. 63-64) that account for state spending on higher education, personal spending on higher education, and economic conditions, and the dependent variable, also summarized in Table 2, accounting for the formation of human capital. To determine if the continuous independent variables were useful in predicting the continuous dependent variable, a multivariate regression analysis procedure was performed to determine the proportion of the variance in the formation of human capital that is predicted by state spending on higher education such that:

\[ Y_{ij} = \beta_{APPCAP}x_{ij} + \beta_{APPFTE}x_{ij} + \beta_{STUDFA}x_{ij} + \beta_{SPTUIT}x_{ij} + \beta_{CPTUIT}x_{ij} + \beta_{PRTUIT}x_{ij} + \beta_{UNEMP}x_{ij} + c \]  

where \( Y \) is total state enrollment in higher education divided by the state population age 18-24, \( \beta \) is the regression coefficient for state appropriations per capita for higher education (APPCAP), state appropriations per public FTE student for higher education (APPFTE), state spending on student grant aid per undergraduate FTE (STUDFA), state average cost of tuition and mandatory fees at four-year public institutions of higher education (SPTUIT), state average cost of tuition and mandatory fees at two-year public institutions of higher education (CPTUIT), state average cost of tuition and mandatory fees at four-year, private institutions of higher education (PRTUIT), and state unemployment rate (UNEMP), all in year \( t \) and state \( j \), and \( c \) is the constant where the regression line intercepts the \( Y \) axis.
The longitudinal analyses use the same model of the relationship between the variables as in the cross-sectional analysis, and add to the model a factor accounting for change over time. Two increments of time, 5-years and 10-years, were used in this analysis to account for change such that:

\[ \Delta Y_{ij} = \beta_{\Delta APPCAP}x_{ij} + \beta_{\Delta APPFTEX}y_{ij} + \beta_{\Delta STUDEFA}x_{ij} + \beta_{\Delta CPTUIT}x_{ij} + \beta_{\Delta PRTUIT}x_{ij} + \beta_{\Delta UNEMP}x_{ij} + c \]  

where \( \Delta \) refers to the change in each of the variables over 5-years and 10-years, respectively.

Given that the analysis of the entire set of states has the potential to mask important variations at the sub-national level with regard to the relationship between the dependent variable and the independent variables, a third set of analyses was performed on groups of states to determine if the ability of the model to explain the variability of human capital formation was improved by dividing the states into groups based on changes in enrollment rates. The change in enrollment rate for each state between 1980 and 2005 was used to group states in three categories about one-third of all states each. The first group contains states with low enrollment growth. The second group contains states with changes in enrollment rates with moderate enrollment growth. The third group contains states with high enrollment growth. Each of the groups was then analyzed in the same way that the entire set of states was analyzed longitudinally using 5-year and 10-year increments of change in the dependent and independent variables.

**Phase 2**

The second phase analyzes time-series data from states, grouped by income inequality and changes in productivity to examine the extent to which changes in state spending on higher education predict changes in the formation of human capital in the context of extremes in productivity and income inequality. As in the first phase, a measure of human capital that is not substantially affected by interstate migration of degree recipients and lag time between educational investment of the state and economic productivity of the recipient was used. The second phase of the research addressed the following research questions: 2b. To what extent does the predictive value of state higher education spending on the formation of human capital vary by state income inequality?; and 2c. To what extent does the predictive value of state higher education spending on
the formation of human capital vary by changes in state productivity? This research also contributed to answering research question number 3. What factors are useful in explaining the relationship between state spending on higher education and the formation of human capital?

To determine if changes in the continuous independent variables are useful in predicting changes in the continuous dependent variable, a multivariate time-series regression analysis procedure was performed for the highest and lowest state quintiles to determine the proportion of the variance in the formation of human capital that is predicted by state spending on higher education such that:

\[ Y_{tj} = \beta_{APPCAP_x}x_{tj} + \beta_{STUDFA_x}x_{tj} + \beta_{SPTUIT_x}x_{tj} + \beta_{PRTUIT_x}x_{tj} + \beta_{CPTUIT_x}x_{tj} + \beta_{UNEMP_x}x_{tj} + c \]  

where \( Y \) is the 10-year change in the percent of each state’s total population enrolled in higher education, \( \beta \) is the beta values or regression coefficients for the 10-year change in state appropriations per capita for higher education (APPCAP), the 10-year change in state spending on student financial aid (STUDFA), the 10-year change in state average cost of tuition and fees at four-year public institutions of higher education (SPTUIT), the 10-year change in state average cost of tuition and fees at four-year private institutions of higher education (PRTUIT), the 10-year change in state average cost of tuition and fees at two-year public institutions of higher education (CPTUIT), and the 10-year change in state unemployment rate (UNEMP), all in year \( t \) and state \( j \), and \( c \) is the constant where the regression line intercepts the \( Y \) axis.
CHAPTER 4
STATE SPENDING ON HIGHER EDUCATION AND THE FORMATION OF HUMAN CAPITAL

Abstract

This study contributes to the literature on the economic value of higher education by examining the extent to which a set of independent variables, including two measures of state spending on higher education predict the formation of human capital. The findings suggest that, in most states, increases in state spending per full-time equivalent enrollment in public higher education predict decreases in the formation of human capital, while increases in state spending per capita on public and private higher education predict increases in the formation of human capital. This suggests that the relationship between state spending on higher education and the formation of human capital is dependent on the measure of state spending used. Attempts to increase the formation of human capital should focus on increasing state spending per capita on public and private higher education.
Introduction

Advocates for higher education have little research at their disposal that clearly links state spending on higher education to economic growth. What research does exist is largely focused on the economic value that state spending on higher education produces via improvements in technology brought on by research (Jaffe, 1989; McMahon, 1992) and not the development of human capital in the recipients of higher education (Vedder, 2004a). This lack of evidence, coupled with theories that suggest that higher education is little more than a screening device used by employers and a signaling device used by potential employees, has led some to argue that public money spent on higher education is wasteful (Vedder, 2004a; 2004b).

Theoretical Explanations

According to the theory of signaling and screening, a college degree is both a screening mechanism, use by employers to select candidates who are less likely to be absent, use illicit drugs, or steal from the company than potential employees who lack a college degree, and a signaling mechanism used by candidates to signify that they are predisposed to be more intelligent and more productive than those who lack the credential (Arrow, 1973; Spence, 1973; Stiglitz, 1975). Further, a college education does little to contribute to the productivity of its recipients. As a consequence of this theory, and research findings that appear to support it, some have argued that public money spent on higher education is wasteful and that there are more efficient ways to screen for productive employees than to provide public subsidies for higher education (Brown & Sessions, 2004; Keller 2006; Vedder, 2004a) as a matter of public policy.

A study by Eric Vedder (2004a) examined the private and public returns to education by examining the relationship between state spending on higher education and measures of economic growth. Vedder (2004a) concluded that his analysis supported the constructs of signaling and screening. This conclusion was based, in part, on the finding that state spending on higher education, as measured by the proportion of state personal income spent by state and local governments, was negatively associated with economic growth, as measured by real personal income per capita. Moreover, Vedder’s study did not afford evidence that state spending on higher education contributed to the formation of human capital, as defined by the portion of the population with college degrees.
Recent research has generally discredited a model of the relationship between higher education and economic growth that is based wholly on signaling and screening (Brown & Sessions, 2004). Human capital theory suggests, and empirical evidence supports the opposing view, that the relationship between state spending on higher education and productivity is more direct than state spending on higher education and economic growth (Becker, 1993; Hojo, 2003). Further still, research studies using a human capital framework have suggested the existence of variables not considered by Vedder in studying the relationship between state spending and economic growth.

In contrast to the theory that higher education is a signaling or screening device, human capital theory is based on the premise that education raises the productivity of its recipients, thereby increasing wages (Bowen, 1964; Becker, 1993; Schultz, 1971). According to human capital theory, education produces economic benefits, both private and public, through increasing productivity. Skills and ability gained through education that heighten productivity, are said to be human capital. Human capital theory posits that previously unaccounted for growth in the economy has been the result of investments in human capital (Becker, 1993; Schultz, 1971). This construct is supported by the findings from a number of studies, including those conducted by Denison (1985), Jorgenson, and Fraumeni (1993), Thomas, Wang, and Fan (2001), and Hsing (2005).

While productivity and economic growth are strongly related such that productivity is a strong source of economic growth (Bureau of Labor Statistics, 2004; Clarke, Durand, Pilat, & Torres, 2001; OECD, 2006; Sweetland, 1996), the two concepts are not synonymous. In studying the relationship between education, productivity, and economic growth, Hojo (2003) found that education has a more direct impact on productivity than on economic growth. Human capital theory attributes economic growth to the gains in productivity realized from investments in human capital, such as education (Becker, 1993). Increases in educational spending that result in increases in educational attainment indirectly affect economic growth through direct improvements in productivity.

Despite theoretical and empirical evidence supporting human capital theory and the accumulation of evidence discrediting the theory of signaling and screening, little research has been conducted using a human capital theory framework to examine the
relationship between state spending on higher education and economic growth. This may be due, in part, to the methodological challenges facing researchers.

Methodological Obstacles to Studying Economic Benefits at the State Level

The conundrum faced by researchers in investigating this relationship is three-fold. The methodologies used in state-level studies have precluded the production of evidence supporting or refuting the relationship between spending and the economic benefits that result from the human capital embodied in the recipients of higher education because: (a) research has focused on all levels of education, rather than higher education specifically; (b) research has failed to account for the interstate migration of recipients of higher education and lag time between investment and economic gains (Gittell & Sedgley, 2000; Quan & Beck, 1987; Strathman, 1994); and (c) research has focused on the relationship between state spending and economic growth rather than the intermediate and direct relationships between spending and the formation of human capital, human capital and productivity, and productivity and economic growth (Becker, 1993; Checchi, 2003; Denison, 1985; Hojo, 2003; Mincer, 1974; Schultz, 1971).

First, some studies have produced evidence of a relationship between all levels of education and economic benefit, but have not focused exclusively on higher education (Becker & Lewis, 1992; Carpentier, 2006; Keller, 2006; Webber, 2002). These have identified a positive relationship between investment in education and economic growth (see Barro & Sala-I-Martin, 1995; Barro, 1991; Bassanini & Scarpetta, 2001; Greenway & Hayes, 2004; Stevens & Weale, 2004). Using Organization for Economic Cooperation and Development (OECD) data and these findings, Greenway and Hayes (2004) identified higher education as the most relevant education variable among developed countries but little research has been conducted to identify the economic benefits associated with government investment in higher education (Sylwester, 2002). Studies of the economic benefit of higher education, specifically, are needed to inform policymaking.

Second researchers caution that it is very difficult to reach conclusions on the relationship between state spending on higher education and economic growth given that states benefit from the spending of other states, allowing some states to act as free-riders (Gittell & Sedgley, 2000; Quan & Beck, 1987; Strathman, 1994). For example, a state
may expend money to provide higher education to students who leave the state after obtaining a degree. In addition, Aschauer found that the time lag between government spending, the actual education of the workforce, and the eventual impact on productivity is “long and varied enough to sever any contemporaneous link between public expenditures on [education] and private sector productivity” (1992, p. 89).

Third, theoretical (Becker, 1993; Denison, 1985; Mincer, 1974; Schultz, 1971) and empirical evidence (Denison, 1985; Hojo, 2003) suggest that the relationship between state spending on higher education and the formation of human capital, human capital and productivity, and productivity and economic growth are each individually more direct than a relationship between state spending on higher education and economic growth. The theoretical underpinnings of the relationship between state spending and the formation of human capital, human capital and productivity, and productivity and economic growth may shed additional light on the study of the relationship between state spending on higher education and economic benefits arising from the embodiment of human capital in the recipients of higher education.

**Theoretical and Practical Models**

The literature identifies that a relationship exists between state spending on higher education, human capital, productivity, and economic growth, such that human capital, and productivity are each intermediate factors in the relationship between educational spending and economic growth (Becker, 1993; Black & Lynch, 1996; Checchi, 2003; Mayer, 2001; Hojo, 2003). Specifically, the model postulates that educational spending affects the formation of human capital that affects productivity which, in turn, affects economic growth.

The relationships are theorized to have single direction causation such that an increase in educational spending causes an increase in human capital (Checchi, 2003; Mayer, 2001), an increase in the formation of human capital causes an increase in productivity (Becker, 1993; Hojo, 2003), and an increase in productivity causes an increase in economic growth (Becker, 1993). Figure 7 represents this theoretical model of the relationship between these factors.

The model depicted in Figure 7 addresses two of the methodological obstacles previously outlined in that the model is limited to spending on higher education and
Figure 7. Theoretically Based Model of the Relationship between Educational Spending and Economic Growth
accounts for a direct relationship between human capital and productivity as well as the relationships between human capital and income inequality and productivity and income inequality. However, the model does not explicitly address the issues of interstate migration or lag time between spending on higher education and economic benefits. As such, the model described in Figure 7 becomes impractical when attempts are made to apply the model at the state level. Interstate migration of degree recipients that overburdens some states while allowing other states to act as free-riders (Gittell & Sedgley, 2000; Quan & Beck, 1987; Strathman, 1994) and the lag time between state investment in higher education and increases in economic productivity on the part of degree recipients (Aschauer, 1992) severely limit the practical testing of the model illustrated in Figure 7.

Stock measures of human capital, such as the number of people in a population with a college degree, may be correlated or regressed with an economic index, such as growth in gross domestic product (Psacharopoulos & Patrinos, 2004); this form of analysis is often performed at the national-level where the effects of migration are minimal (Checchi, 2001). However, it is inappropriate to correlate a stock measure of human capital with state spending on higher education given that interstate migration and variations in the lag time between investment and productivity reduce the meaningfulness of the correlation (Aschauer, 1992; Gittell & Sedgley, 2000). The complications brought on by interstate migration and lag time are possible reasons why Vedder (2004a) found no relationship between state spending on higher education and the stock of human capital (i.e., the percentage of the population with a college degree). To overcome the impediment of measuring the relationship between human capital and economic benefit, flow measures of human capital, such as the number of people participating in higher education, may be used to account for the formation of human capital and, therefore, may be predicted by state spending on higher education.

Although flow measures of human capital may be useful in measuring the relationship between state spending on higher education and the formation of human capital in that flow measures overcome the obstacles presented by interstate migration and lag time, such measures are inappropriate for testing the relationship between human capital and state-level economic productivity. Flow measures of human capital, by
definition, do not account for existing human capital that contributes to state-level economic productivity (McNamara, Kriesel, & Denton 1988; Psacharopoulos & Patrinos, 2004). That is, those enrolled in higher education are unlikely to participate fully in the workforce, and therefore boost economic productivity.

Given these constraints, the model outlined in Figure 7 cannot be tested using a single variable that accounts for human capital. Instead, the model may be tested in two parts. The first of two parts may test the relationship between state spending on higher education and the formation of human capital using a flow measure of human capital, such as the percentage of the state population currently enrolled in higher education. An illustration of this model is provided in Figure 8.

This research will focus on the relationship depicted in Figure 8 and will examine the cross-sectional and longitudinal relationship between state spending on higher education and the formation of human capital such that state spending on higher education is used to predict a flow measure of human capital. The remainder of the model depicted in Figure 7, that which contains the relationship between human capital, productivity, and economic growth, is not the focus of this study but can be tested using stock measures of human capital. Empirical and theoretical evidence from the literature supports the existence of these relationships (Becker, 1993; Black & Lynch, 1996; Bureau of Labor Statistics, 2004; Denison, 1985; Clarke, Durand, Pilat, & Torres, Sweetland, 1996).

The purpose of this study is to contribute to the body of research on the public economic benefits of higher education by examining the relationship between state spending on higher education and state-level formation of human capital using the lens afforded by the constructs of human capital theory. In the interest of overcoming the unique obstacles associated with measuring economic benefits of higher education at the state-level, a model of the relationship between state spending on higher education and the formation of human capital is constructed based on human capital theory literature.
Figure 8. Theoretically Based Model of the Relationship between Higher Education Spending and the Formation of Human Capital
Methods

The study unfolds in three parts. The first part examines the extent to which state spending on higher education predicts the formation of human capital among all 50 states in years 1980-2005, excluding years 1999 and 2001 for which dependent variable data are not available. The second part examines the extent to which longitudinal changes in state spending on higher education predict changes in the formation of human capital. The third part examines the extent to which the predictive value of state higher education spending on the formation of human capital varies by longitudinal changes in enrollment rate.

For each of the three parts, the relationship between state spending, an independent variable, and enrollment in higher education, the dependent variable is tested. Higher education enrollment is a flow measure of human capital that is not substantially affected by interstate migration of degree recipients and lag time between educational investment of the state and economic productivity of the recipient (Psacharopoulos & Patrinos, 2004). In addition to measures of state spending on higher education, other independent variables that affect the formation of human capital, identified by the literature, will be included in the analysis. These variables include tuition effects (Heller 1999, Leslie & Brinkman 1988; Paulsen, 1998), financial aid effects (Braunstein, McGrath, & Pescatrice, 1999; Heller 1999), and the economic effects (Heller, 1996, 1999; Macunovich, 1997).

Sampling Procedure

The unit of analysis for this study is the state. All 50 states are analyzed in each of the three analyses. In the third set of analyses—which examine the extent to which the predictive value of state higher education spending on the formation of human capital vary by longitudinal changes in enrollment rate—states are grouped by changes in enrollment rate.

Data Collection

Data for this analysis were collected from national sources. State-level data on fall undergraduate enrollment and undergraduate tuition at public and private non-profit and for-profit degree-granting colleges and universities were obtained from the Integrated Postsecondary Education Data System (IPEDS), which is administered by National
Center for Educational Statistics of the U. S. Department of Education. IPEDS enrollment data were not available in 1999. State population data were obtained from the U.S. Census Bureau’s population estimate program. State population data, broken out by the specified age range, were not available in 2001. Enrollment rates in years 1980-2005, excluding 1999 and 2001, were calculated using a method employed by Heller (1996, 1999) that divides total state enrollment in higher education by the state population age 18 to 24. As noted by Heller (1996), such a method assumes that the denominator represents the traditional but not the entire college-going population and acknowledges that the numerator includes students that fall outside of that age range. At the same time, this measure is a limitation of the study in that 18- to 24-year olds are not only college going population.

Financial aid data were obtained from the annual survey results of the National Association of State Student Grant and Aid Program and consist of the estimated undergraduate grant dollars per FTE undergraduate student, by state. Unemployment data were collected from the U.S. Bureau of Labor Statistics and consist of state unemployment rates.

Two sets of data were obtained to account for state spending on higher education. The two complementary and unique measures of state spending on higher education were used to capture different aspects of state spending on higher education. The first measure of appropriations per capita includes spending on public and independent institutions of higher education. The second measure of appropriations per public full time equivalent (FTE) enrollment includes only spending on public institutions and removes spending on elements of higher education that are not directly related to teaching and learning such as research, agriculture, and medical expenditures. Both measures were standardized across states; the first by dividing the total sum of expenditures by the population and the second by dividing the sum of expenditures on public higher education by the number of FTE enrollments in higher education. Data on both measures of state higher education spending were obtained from the State Higher Education Finance survey administered annually by the State Higher Education Executive Officers. These data, along with tuition data and financial aid data were held constant in 2006 dollars.

Data Analysis
For the cross-sectional analysis, a single regression equation was calculated in which each year for each state served as a unique case. To determine if the continuous independent variables are useful in predicting the continuous dependent variable, a multivariate regression analysis procedure was performed to determine the proportion of the variance in the formation of human capital that is predicted by state spending on higher education such that:

\[ Y_{tj} = \beta_{APPCAP}x_{tj} + \beta_{APPFTE}x_{tj} + \beta_{STUDFA}x_{tj} + \beta_{SPTUIT}x_{tj} + \beta_{CPTUIT}x_{tj} + \beta_{PRTUIT}x_{tj} + \beta_{UNEMP}x_{tj} + c \]  

(6)

where \( Y \) is total state enrollment in higher education divided by the state population age 18-24, \( \beta \) is the regression coefficient for state appropriations per capita for higher education (APPCAP), state appropriations per public FTE student for higher education (APPFTE), state spending on student grant aid per undergraduate FTE (STUDFA), state average cost of tuition and mandatory fees at four-year public institutions of higher education (SPTUIT), state average cost of tuition and mandatory fees at two-year public institutions of higher education (CPTUIT), state average cost of tuition and mandatory fees at four-year, private institutions of higher education (PRTUIT), and state unemployment rate (UNEMP), all in year \( t \) and state \( j \), and \( c \) is the constant where the regression line intercepts the \( Y \) axis.

The longitudinal analyses used the same model of the relationship between the variables as in the cross-sectional analysis, and add to the model a factor accounting for change over time. Two increments of time, 5-years and 10-years, are used in this analysis to account for change such that:

\[ \Delta Y_{tj} = \beta_{\Delta APPCAP}x_{tj} + \beta_{\Delta APPFTE}x_{tj} + \beta_{\Delta STUDFA}x_{tj} + \beta_{\Delta SPTUIT}x_{tj} + \beta_{\Delta CPTUIT}x_{tj} + \beta_{\Delta PRTUIT}x_{tj} + \beta_{\Delta UNEMP}x_{tj} + c \]  

(7)

where \( \Delta \) refers to the change in each of the variables over 5-years and 10-years, respectively.

Results

**Predicting Human Capital from State Spending on Higher Education**

The model was applied to all states in years 1980 to 2005, excluding years 1999, and 2001 for which enrollment rate data were not available. The examination of the cross-sectional relationship between the formation of human capital, the dependent
variable and the independent variables resulted in the identification of a set of variables that predict the dependent variable. The complete set of significant variables included appropriations for public and private higher education per capita (APPCAP), appropriations for public higher education per FTE (APPFTE), tuition and fees at public four-year institutions (SPTUIT), and tuition and fees at private four-year institutions (PRTUIT). Tuition and fees at public two-year institutions (CPTUIT), state unemployment rate (UNEMP), and student financial aid (STUDFA) were not significant predictors of the dependent variable (see Table 3).

The values in Table 3 reflect an adjustment for the removal of autocorrelation, or the correlation of the residuals for adjacent observations over time, from the residuals of the time-series data using a procedure explained by Netter, Kutner, Wasserman, & Nachtsheim, (1996), which builds on the work of Cochrane and Orcutt (1949). Following the application of the Cochran-Orcutt procedure, a Durbin-Watson statistic (Durbin & Watson, 1951) was computed to test for first-order autocorrelation. The application of the Cochran-Orcutt procedure to the data reduced first-order autocorrelation such that the Durbin-Watson statistic was improved from 0.258 to a Durbin-Watson statistic of 1.70.

In addition to the use of a Durbin-Watson statistic, additional measures were used to determine if any of the assumptions of regression equations had been violated and to determine how well the data fit the model. Tolerance and variance inflation factors were computed for the data and neither set of factors were indicative of a problem with multicollinearity. Leverage statistics, Cook’s distance, and df Betas were also normal, indicating that none of the individual data points were outside the general linear pattern.

In addition to determining if any of the required conditions of the regression analysis were violated, statistics were calculated to determine how well the model fit the data. A multiple R and a coefficient of determination were calculated to determine if the data fit the model. A multiple R value of 0.279 was calculated using the model. In addition, the F statistic of 6.913 was significant at the .001 level, indicating the group of independent variables in the model can be used to predict enrollment rates. Multiple R values of less than 0.3 are weak (Cohen, 1988). The $R^2$ value, or the proportion of variability in the data set that is accounted for by the model, was 0.077, indicating that
Table 3

*Concurrent Predictors of Enrollment Rates*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Standardized β coefficient</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPCAP</td>
<td>0.167</td>
<td>3.042*</td>
</tr>
<tr>
<td>APPFTE</td>
<td>-0.152</td>
<td>-2.719*</td>
</tr>
<tr>
<td>STUDFA</td>
<td>-0.012</td>
<td>-0.379</td>
</tr>
<tr>
<td>SPTUIT</td>
<td>0.101</td>
<td>2.947*</td>
</tr>
<tr>
<td>PRTUIT</td>
<td>0.125</td>
<td>3.885*</td>
</tr>
<tr>
<td>CPTUIT</td>
<td>.043</td>
<td>1.336</td>
</tr>
<tr>
<td>UNEMP</td>
<td>.049</td>
<td>1.539</td>
</tr>
</tbody>
</table>

* α ≥ .01
about 8% of the variance in the dependent variable was accounted for by the model. In all, the data appear to fit the model while no assumptions appear to have been violated, but the model of the cross-sectional relationship was weak.

**Longitudinal Changes in State Spending on Higher Education in All States**

The first analysis focused on the cross-sectional relationship between the formation of human capital and a set of independent variables that included two measures of student spending, yet most of the literature on state higher education enrollment is concerned with the longitudinal relationship between the formation of human capital and independent variables. Such studies often examined the relationship between changes in independent variables, such as tuition, financial aid, and unemployment, and the formation of human capital.

The results of this set of longitudinal analyses reveal that all of the independent variables were significant predictors of the formation of human capital (see Table 4). The analysis of the relationship between the variables over a 5-year period identify changes in appropriations for public and private higher education per capita, appropriations for public higher education per FTE, tuition and fees at private four-year institutions, tuition and fees and public two-year institutions, and state unemployment rate as significant predictors of changes in enrollment rates. Changes in appropriations for public and private higher education per capita and tuition and fees and public two-year institutions were positively related to enrollment rates. Appropriations for public higher education per FTE, tuition and fees at private four-year institutions, and state unemployment rate were negatively related to enrollment rates. The 10-year analysis included the same predictors as the 5-year analysis with the exception of state unemployment rate and added to these student financial aid and tuition and fees at public four-year institutions, which were both negatively related to enrollment rates.

As in the first analysis, measures were used to identify violations of the assumptions of regression equations and to determine how well the data fit the model. Durbin-Watson statistics (Durbin & Watson, 1951) of 1.67 and 1.81 were computed for the 5- and 10-year changes in variables, respectively, indicating little or no problem with first-order autocorrelation. As in the first analysis, there was no indication that multicollinearity or outliers were present in the data. Multiple R values and coefficients
Table 4

*Predictors of Change in Enrollment Rates Over 5- and 10-Years*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Standardized β 5-Year Difference</th>
<th>t-Value</th>
<th>Standardized β 10-Year Difference</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPCAP</td>
<td>0.486</td>
<td>8.436*</td>
<td>0.400</td>
<td>6.434*</td>
</tr>
<tr>
<td>APPFTE</td>
<td>-0.573</td>
<td>-9.294*</td>
<td>-0.320</td>
<td>-5.185*</td>
</tr>
<tr>
<td>STUDFA</td>
<td>-0.061</td>
<td>-1.806</td>
<td>-0.112</td>
<td>-3.015*</td>
</tr>
<tr>
<td>SPTUIT</td>
<td>-0.075</td>
<td>-1.942</td>
<td>-0.156</td>
<td>-4.041*</td>
</tr>
<tr>
<td>PRTUIT</td>
<td>-0.094</td>
<td>-2.787*</td>
<td>-0.102</td>
<td>-2.637*</td>
</tr>
<tr>
<td>CPTUIT</td>
<td>0.112</td>
<td>3.352*</td>
<td>0.244</td>
<td>6.835*</td>
</tr>
<tr>
<td>UNEMP</td>
<td>-0.177</td>
<td>-4.618*</td>
<td>-0.045</td>
<td>-1.123</td>
</tr>
</tbody>
</table>

* α ≥ .05
of determination were calculated for the 5- and 10-year longitudinal analyses to
determine if the data fit the model. The multiple R value of for the five-year longitudinal
analysis was 0.339 and the coefficient of determination, or R^2, was 0.115. The 10-year
longitudinal analysis had a multiple R of 0.411 and R^2 of 0.169. Multiple R values
between 0.3 and 0.6 are considered moderate (Cohen, 1988).

The longitudinal analyses found that changes in state spending on higher
education, as measured by changes in appropriations for public and private higher
education per capita and appropriations for public higher education per FTE predicted
changes in enrollment rate. The directions of the relationships were divergent in that
changes in appropriations for public and private higher education per capita positively
predicted changes in enrollment rates, while changes in appropriations for public higher
education per FTE negatively predicted changes in enrollment rates. The directions of
these findings were consistent with the analysis of the cross-sectional relationship
between appropriations for public and private higher education per capita and enrollment
rates and appropriations for public higher education per FTE and enrollment rates. In
addition to information about variables accounting for state spending on higher
education, these analyses also offered information about the other variables included in
the model.

Specifically, these analyses identified significant relationships between changes in
the three variables, i.e., tuition and fees at public two-year institutions, student financial
aid, and state unemployment rate, not identified as significant in testing the model of the
cross-sectional relationships. The significant relationships between changes in tuition and
fees at public four-year institutions, tuition and fees at private four-year institutions, and
tuition and fees at public two-year institutions are consistent with the literature in that that
tuition and fees at public four-year institutions and tuition and fees at private four-year
institutions, which account for public four-year tuition and private four-year tuition,
respectively, are negatively related to changes in enrollment rates.

*Longitudinal Changes in State Spending on Higher Education in States Grouped by
Change in Enrollment Rates*

Given that the analysis of the entire set of states has the potential to mask
important variations at the sub-national level with regard to the relationship between the
dependent variable and the independent variables, a third set of analyses was performed on groups of states to determine if the ability of the model to explain the variability of human capital formation was improved by dividing the states into groups based on changes in enrollment rates. The change in enrollment rate for each state between 1980 and 2005 was used to group states in three categories containing 16 or 17 states each (see Table 5). Among all states, the change in enrollment during the period of study ranged from -1.6% to 35.6%. The first group contains states with changes in enrollment rates of less than 14% during the period. These states are referred to as states with low enrollment growth. The second group contains states with changes in enrollment rates of more than 14% but less than or equal to 19% during the period. These states are referred to as state with moderate enrollment growth. The third group contains states with changes in enrollment rates of more than 19% during the period. These states are referred to as states with high enrollment growth. Each of the groups was then analyzed in the same way that the entire set of states was analyzed longitudinally using 5-year and 10-year increments of change in the dependent and independent variables. The results of the analyses are found in Table 6.

Like the longitudinal analysis of all states, the longitudinal analysis of states grouped by enrollment growth resulted in significant findings for each of the variables included in the model. Moreover, the direction of the relationships identified in the longitudinal analysis of all states was consistent with the direction of the relationships identified in the longitudinal analysis of states grouped by enrollment growth. Yet the segregation of the states by enrollment rates revealed that the relationship between changes in the two variables accounting for state spending on higher education, appropriations for public and private higher education per capita and appropriations for public higher education per FTE, were not significant predictors of changes in enrollment rates for states that have experienced moderate growth in enrollment during the period of the study.

Discussion

The cross-sectional analysis of the model, when applied to all 50 states, identified that appropriations for public and private higher education per capita, appropriations for public higher education per FTE, tuition and fees at private four-year institutions, and
<table>
<thead>
<tr>
<th>Low Enrollment Growth</th>
<th>Moderate Enrollment Growth</th>
<th>High Enrollment Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington -1.6%</td>
<td>Wisconsin 14.6%</td>
<td>Georgia 19.4%</td>
</tr>
<tr>
<td>Alaska 2.3%</td>
<td>Texas 14.8%</td>
<td>Pennsylvania 19.9%</td>
</tr>
<tr>
<td>Oregon 7.5%</td>
<td>Vermont 14.9%</td>
<td>North Carolina 20.0%</td>
</tr>
<tr>
<td>Nevada 8.0%</td>
<td>Florida 15.5%</td>
<td>South Dakota 20.5%</td>
</tr>
<tr>
<td>California 10.0%</td>
<td>Mississippi 15.7%</td>
<td>Missouri 20.7%</td>
</tr>
<tr>
<td>New Jersey 11.1%</td>
<td>Delaware 15.8%</td>
<td>Minnesota 20.8%</td>
</tr>
<tr>
<td>Connecticut 11.4%</td>
<td>Virginia 16.4%</td>
<td>Arkansas 21.4%</td>
</tr>
<tr>
<td>Louisiana 11.5%</td>
<td>Maine 16.7%</td>
<td>Indiana 21.6%</td>
</tr>
<tr>
<td>Massachusetts 11.8%</td>
<td>S. Carolina 17.2%</td>
<td>Kansas 22.1%</td>
</tr>
<tr>
<td>Idaho 12.0%</td>
<td>Nebraska 17.3%</td>
<td>Rhode Island 23.0%</td>
</tr>
<tr>
<td>Maryland 12.2%</td>
<td>Michigan 17.7%</td>
<td>West Virginia 23.2%</td>
</tr>
<tr>
<td>New York 12.6%</td>
<td>Ohio 17.8%</td>
<td>New Mexico 24.4%</td>
</tr>
<tr>
<td>Tennessee 12.8%</td>
<td>Utah 18.4%</td>
<td>Wyoming 26.7%</td>
</tr>
<tr>
<td>New Hampshire 13.0%</td>
<td>Illinois 18.6%</td>
<td>North Dakota 26.8%</td>
</tr>
<tr>
<td>Montana 13.1%</td>
<td>Colorado 19.0%</td>
<td>Kentucky 28.8%</td>
</tr>
<tr>
<td>Oklahoma 13.3%</td>
<td>Hawaii 19.0%</td>
<td>Iowa 34.7%</td>
</tr>
<tr>
<td>Alabama 13.9%</td>
<td></td>
<td>Arizona 35.6%</td>
</tr>
</tbody>
</table>
### Table 6

**Predictors of Enrollment Rate Change Over Five- and Ten-Years, by Enrollment Group**

<table>
<thead>
<tr>
<th>Group</th>
<th>Significant Variables</th>
<th>Standardized β</th>
<th>t-Value</th>
<th>Significant Variables</th>
<th>Standardized β</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Growth</td>
<td>PRTUIT</td>
<td>-0.293</td>
<td>-5.013</td>
<td>PRTUIT</td>
<td>-0.266</td>
<td>-4.224</td>
</tr>
<tr>
<td></td>
<td>APPCAP</td>
<td>0.649</td>
<td>6.146</td>
<td>APPCAP</td>
<td>0.331</td>
<td>4.979</td>
</tr>
<tr>
<td></td>
<td>APPFTE</td>
<td>-0.534</td>
<td>-5.258</td>
<td>STUDFA</td>
<td>-0.294</td>
<td>-3.866</td>
</tr>
<tr>
<td></td>
<td>CPTUIT</td>
<td>0.126</td>
<td>2.274</td>
<td>CPTUIT</td>
<td>0.235</td>
<td>3.901</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(R = 0.396)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate Growth</td>
<td>CPTUIT</td>
<td>0.157</td>
<td>2.592</td>
<td>CPTUIT</td>
<td>0.278</td>
<td>4.355</td>
</tr>
<tr>
<td></td>
<td>STUDFA</td>
<td>-0.137</td>
<td>-2.263</td>
<td>STUDFA</td>
<td>-0.178</td>
<td>-3.153</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>UNEMP</td>
<td>-0.202</td>
<td>-2.824</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(R = 0.196)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Growth</td>
<td>APPFTE</td>
<td>-0.521</td>
<td>-5.757</td>
<td>APPFTE</td>
<td>-0.501</td>
<td>-5.851</td>
</tr>
<tr>
<td></td>
<td>UNEMP</td>
<td>-0.256</td>
<td>-3.828</td>
<td>SPTUIT</td>
<td>-0.341</td>
<td>-5.565</td>
</tr>
<tr>
<td></td>
<td>APPCAP</td>
<td>0.231</td>
<td>2.821</td>
<td>APPCAP</td>
<td>0.259</td>
<td>3.085</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CPTUIT</td>
<td>0.151</td>
<td>2.486</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(R = 0.352)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(R = 0.498)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For all listed t-values, $\alpha \geq .05$
tuition and fees at public four-year institutions were each significant predictors of the formation of human capital. Moreover, the model was useful in predicting about 7% of the total variance of in human capital formation. The longitudinal analysis of the model, when applied to all 50 states and used to regress the 5- and 10-year differences in the dependent variable and independent variables, identified all of the variables included in the original model as significant predictors of the formation of human capital (see Table 5). The application of the model to the 5- and 10-year differences in the variables permitted for the prediction of about 12% and 15% of the variance in the change of the formation of human capital during the respective amounts of time. The longitudinal analysis of the model, when applied to states grouped by enrollment rate growth, was useful in predicting as much as 25% of the variance in the change of the formation of human capital over time.

The 5-year longitudinal analysis identified changes in appropriations for public and private higher education per capita, appropriations for public higher education per FTE, tuition and fees at private four-year institutions, tuition and fees at public two-year institutions, and state unemployment rate as significant predictors of changes in enrollment rates. Changes in appropriations for public and private higher education per capita and tuition and fees at public two-year institutions were positively related to enrollment rates and appropriations for public and private higher education per capita, tuition and fees at private four-year institutions. State unemployment rates were negatively related to enrollment rates. The 10-year analysis included the same predictors as the 5-year analysis with the exception of state unemployment rates and added to these student financial aid and tuition and fees at public four-year institutions, which were both negatively related to enrollment rates. The 5-year longitudinal analysis identifies that the model was useful in predicting about 12% of the variance, while that 10-year model was useful in predicting about 17% of the variance.

The analysis of states grouped by enrollment rates revealed that the models gain predictive power as the period of time examined increases. For example, the $R^2$ values of the 5-year longitudinal examination range from less than 0.10 to less than 0.20. The $R^2$ values of the 10-year longitudinal examination range from just more than 0.15 to about 0.25. To be sure, an analysis of the 15-year change in the variables was conducted. It
revealed that the $R^2$ value increased to a range of just under 0.20 to more than 0.30 while the significance and the direction of independent variables identified in predicting the dependent variable remained relatively constant within the groups over the different longitudinal intervals. For example, changes in appropriations for public and private higher education per capita, tuition and fees at private four-year institutions, tuition and fees at public two-year institutions are significant predictors of changes in enrollment rates over 5-year and 10-year periods for states in the low enrollment growth group. The same was true with regard to tuition and fees at public two-year institutions and student financial aid for the moderate enrollment growth group as well as appropriations for public and private higher education per capita and appropriations for public higher education per FTE for the high enrollment growth group.

**State Spending Measures and Human Capital Formation**

Two measures of state spending on higher education were included in the model to account for different forms of state spending on higher education. These measures are state and local appropriations for general operating expenses of public and independent higher education per capita, and state and local appropriations for general operating expenses of public higher education less research, agriculture, and medical expenditures per non-medical FTE enrollment.

In the analyses, appropriations for public and private higher education per capita, when determined to be a significant predictor of the dependent variable, were consistently positively associated with enrollment growth. At the same time, appropriations for public higher education per FTE were consistently negatively associated with enrollment growth, when determined to be a significant predictor of the dependent variable. Plausible reasons exist for this seemingly contradictory finding given that the two measures are intended to capture unique elements of state spending on higher education. The very differences in the measures may add some additional insight into the relationship between state spending and the formation of human capital.

Recall that the two measures of state spending are intended to capture complementary and unique components of state spending on higher education. While appropriations for public and private higher education per capita included spending on public and independent institutions of higher education, appropriations for public higher
education per FTE included only spending on public institutions. Moreover, appropriations for public higher education per FTE removed spending on elements of higher education that were not directly related to teaching and learning such as research, agriculture, and medical expenditures and was standardized across states by dividing the total sum of expenditures by the number of FTE students enrolled in higher education. Appropriations for public and private higher education per capita included higher education spending of all types and were standardized by dividing the total sum of the expenditures by the population of the state.

The consistent direction of the relationship between appropriations for public and private higher education per capita and human capital formation, as measured by enrollment rates, suggests that increases in higher education spending, including expenditures for private higher education, relative to the population of the state have a positive effect on the formation of human capital. At the same time, the consistent direction of the relationship between appropriations for public higher education per FTE and changes in human capital formation also suggests that increases in higher education spending for public institutions, exclusive of research, agriculture, and medical expenses, have a negative effect on enrollment rates. While these findings appear contradictory, both are feasible if: public spending that benefits private institutions of higher education has a positive effect on state human capital formation; public spending relative to the state population, rather than relative to the FTE of public institutions, has a positive effect on human capital formation; or, though less intuitive, public spending on university research, agriculture, and medicine has a positive effect on human capital formation.

The results of the first analysis, which included all 50 states and examined the cross-sectional relationship between the independent variables and human capital formation, indicate that there was a relationship between state spending on higher education and the formation of human capital, but that relationship was weak. The second and third set of analyses examined the longitudinal relationship of the variables by regressing the changes in the independent variables and changes in the dependent variable over 5- and 10-years, respectively. These analyses identified that the variables included in the model were significant. In addition to recognizing each of the variables,
the strength of the model in predicting the dependent variable was improved by the longitudinal analysis.

The third set of analyses indicates that the relationship between state spending on higher education and the formation of human capital varies according to the state’s enrollment rate. That is, states with the high enrollment rate growth demonstrated a strong relationship between enrollment rates and state spending, but the direction of that relationship varied according to the variable used. The same was true for states for with low enrollment rates. However, states with moderate enrollment rate growth demonstrated no significant relationship between changes in enrollment rates and changes in state spending, as measured by both state spending on higher education per public FTE and per capita.

The longitudinal analysis of the states segregated by enrollment levels indicates that higher levels of state spending do not benefit all states equally. By regressing state spending and enrollment rates for three distinct groups of states rather than examining all states in aggregate, it becomes clear that the relationship between state spending and human capital formation is not the same for all states. The analysis leads to the conclusion that states with high and low enrollment rate growth may benefit from increases in state spending on public and private higher education per capita while states with moderate enrollment growth do not benefit from that same type of spending. The analysis must also lead to the conclusion that state spending on public higher education per FTE net expenses in research, agriculture, and medicine, serves as a detriment to enrollment rate growth in states with high and low enrollment rate growth. These findings suggest that attempts to increase the formation of human capital should focus on increasing state spending per capita on public and private higher education.

Conclusion

This study attempts to overcome the methodological obstacles associated with measuring the relationship between state spending on higher education and economic growth by examining the intermediate relationship expected between state spending on higher education and the formation of human capital. The study provides evidence supporting a model that may be used in understanding the formation of human capital, as measured by higher education enrollment. The findings of this study illuminate the
existence of a negative relationship between appropriations for public higher education per full-time equivalent student and the formation of human capital as well as a positive relationship between appropriations for public and private higher education per capita and the formation of human capital.

The findings from this study indicate that the nature of the relationship between state spending on higher education and the formation of human capital may be contingent upon the specific definition of state spending on higher education. Decreases in state spending on public higher education per full-time equivalent student are related to increases in the formation of human capital in states with high and low enrollment rate growth. At the same time, increases in state spending on public and private higher education per capita was related to increases in the formation of human capital in the same states. Therefore policymakers may wish to consider this finding in the appropriation of funding for higher education. If the intent of policymakers is to increase the formation of human capital, then focus should be placed on increasing in state spending per capita on public and private higher education rather than on increases in per public full time equivalent student.

Future studies may seek to further isolate the conditions under which variables accounting for state higher education spending interact with the formation of human capital. In doing so, studies might examine how state spending on public versus private institutions affects the formation of human capital within given states. Studies might also investigate the relationship between human capital formation and changes in spending relative to the total population of a state versus spending relative to the number of student already enrolled.

Finally, future studies might build on the findings in this study to examine the relationship between measures of human capita, productivity, and the economic growth to further contribute to the understanding of the economic value of higher education.
CHAPTER 5
AN ANALYSIS OF STATE HIGHER EDUCATION SPENDING AND THE FORMATION OF HUMAN CAPITAL IN THE CONTEXT OF EXTREMES IN INCOME INEQUALITY AND PRODUCTIVITY CHANGE

Abstract
In an effort to contribute to the body of literature on the economic benefits of higher education, this study analyzes time-series data from states, grouped by income inequality and changes in productivity, to examine the extent to which changes in state spending on higher education predict changes in the formation of human capital. The results indicate that increases in state higher education spending do not benefit all states. Increases in state higher education spending predict increases in the formation of human capital in states with low productivity growth and in states with low levels of income inequality. In states with high productivity growth, increases in state higher education spending predict decreases in the formation of human capital.
Introduction

While it is widely held that increases in educational attainment result in increases in productivity which, in turn, contribute to economic growth (Becker, 1993; Denison, 1984; Schultz, 1971; Wheeler, 2006), the public economic benefit of state spending on higher education has recently been called into question (Vedder 2004a, 2004b). Studies by Denison (1985), Jorgenson and Fraumeni (1993), Thomas, Wang, and Fan (2001), and Hsing (2005) offer evidence supporting a causal relationship between increases in education and increases in economic growth, yet research by Vedder (2004a, 2004b) questions the role of the state government in financing higher education. Vedder (2004a) found that state spending on higher education was negatively associated with economic growth.

Given that evidence supports a positive, even causal, relationship between human capital and economic growth (Becker, 1993), one might expect state spending aimed at increasing the stock of human capital to result in increases in economic growth. However, previous research showed that the interstate migration of the beneficiaries of state spending on higher education (Gittell & Sedgley, 2000; Quan & Beck, 1987) compounded by a lag time between state spending on education and projected private productivity of beneficiaries of state spending (Aschauer, 1992) severely reduce, if not eliminate, practical examinations of the relationship between state spending on higher education and flow measures of human capital. Therefore, only a limited body of research on the relationship between state spending on higher education and economic growth exists and that which does exist is reliant on flow, rather than stock measures of human capital (Vedder, 2004a; Williams & Swail, 2005).

To understand the relationship between state spending on higher education and economic growth, it is necessary to investigate the critical intermediate relationship between state spending on higher education and the formation of human capital. This study analyzes time-series data from states, grouped by income inequality and changes in productivity, to determine the extent to which changes in state spending on higher education predict changes in the formation of human capital and the extent to which any identified predictions vary by state income inequality and changes in state productivity.
The results of this analysis may contribute to a better understanding of the relationship between state spending and economic growth.

Theoretical Model

Public investment in higher education is often aimed at increasing the formation of human capital with the intention of improving economic growth (Greenway & Hayes 2004; OECD, 2006). Previous studies have examined specific ways in which public spending on higher education has influenced the formation of human capita. Models used to explain the formation of human capital, frequently measured in terms of higher education enrollment (Psacharopoulos & Patrinos, 2004), have focused on the tuition effects (Heller 1999, Leslie & Brinkman 1988; Paulsen, 1998), on financial aid effects (Braunstein, McGrath, & Pescatrice, 1999; Heller 1999), and economic condition effects (Boilard, et al., 2005; Heller, 1996, 1999; Macunovich, 1997) at the institution and student level. Few studies have examined these effects on the formation of human capital at the state level and even fewer have examined the effects of all state higher education spending on the formation of human capital, thereby limiting the utility of previous studies for state policymakers interested in fostering the formation of human capital.

The literature indicates a causal relationship between tuition and enrollment such that reduced tuition increases enrollment for low income students (Heller, 1996; Leslie & Brinkman 1988). Yet, the relationship between tuition and enrollment is made more complex when consideration is given to separate measures of public four-year institution tuition and community college tuition. Rouse (1994) found that the relationship between tuition increases and enrollment at public, two-year colleges can be positive if tuition increases at public-four year institutions at the same time.

The relationship between financial aid and enrollment is complex given the varying forms of financial aid (Heller, 1996), yet studies have identified that financial aid effects can reduce tuition effects in that financial aid may offset the sticker price of college and create a net price that is more affordable, thereby relieving high tuition prices (Heller, 1997; St. John, 1990). Among the various forms of financial aid, grants are the form most frequently sponsored by states and vary significantly among states (National Association of State Student Grant and Aid Programs, 2007). The general assumption surrounding grants is summarized in the findings of Leslie and Brinkman (1988) who
reviewed a broad range of studies and concluded that grant aid increases the enrollment of low-income individuals such that greater proportions of low-income individuals participated in higher education after the implementation of federal grant programs than before. Yet, the work of Hansen (1983) appears to refute such claims in that his findings identified no such relationship between a federal grant program and the enrollment of low or middle income individuals.

The literature identifies that economic conditions also affect enrollment rates. Longitudinal studies by Heller (1996, 1999) and Macunovich (1997) have quantified the economic conditions affecting enrollment rates by measuring the relationship between unemployment and the formation of human capital. These longitudinal studies and those by Savoca (1990), Hsing and Chang (1996), and Betts and McFarland (1995) consistently identified a positive relationship between unemployment and the formation of human capital. Such studies attribute the positive relationship to the logic that lower unemployment rates serve as a sign that economic conditions are favorable for finding employment thereby encouraging participation in the labor market rather than higher education, while higher unemployment rates have the opposite effect.

In addition to economic condition effects, financial aid effects, and tuition effects on the formation of human capital, the literature also identifies that productivity and income inequality may be related to the formation of human capital (Becker, 1993). Moreover, these factors may provide additional information on the relationship between state spending and economic growth. Unlike economic conditions, financial aid, and tuition, the literature indicates that the expected relationship between measures of productivity and income inequality on human capital is not strictly causal. The literature identifies productivity as a factor that should, by definition of human capital theory, be the result of human capital rather than a cause (Becker, 1993; Mincer, 1974; Schultz, 1971). Yet, the findings of Thomas, Wang and Fan (2001) and Hsing (2005) also indicate an element of mutual causality in the relationship between the formation of human capital and income, which is often used as a proxy for productivity at the state level (Vedder, 2004a). The literature on income inequality appears to indicate that income inequality is both a cause and an effect of human capital formation (Mayer 2001; Checchi, 2000, 2001; Bishop, Formby, & Thistle, 1992; Sylwester 2002).
Productivity, a measure of economic efficiency, is a significant source of economic growth (Bureau of Labor Statistics, 2004; Clarke, Durand, Pilat, & Torres, 2001; OECD, 2006). Unlike economic growth, productivity increases are the expected direct outcome of increases in the formation of human capital and is described by the literature on human capital as the link between education and economic growth (Becker, 1993; Black & Lynch, 1996; Mincer, 1974; Schultz, 1971; Wheeler, 2006). Studies of education and productivity have resulted in findings that support the claim made by human capital theorists that education raises productivity (Bishop, 1994; Black & Lynch, 1996; Denison, 1985; Jorgenson & Fraumeni, 1993). If spending on higher education raises attainment levels, then human capital theory would suggest that there should be an increase in subsequent productivity levels.

Output per hour of labor is used to measure productivity at the national-level (BLS, 2004). Data on output per hour of labor is not consistently available at the state-level; therefore personal income is frequently used as a proxy for productivity (Vedder, 2004a). Personal income is also a measure of wealth; therefore, using personal income as a proxy for productivity at the state level results in findings that are applicable to both wealth and productivity. While productivity, in and of itself, is not identified by the literature as a predictor of human capital formation, its proxy at the state-level is.

Previous studies of the relationship between personal income and higher education have identified that income is a predictor of higher education enrollment for individual students (Leslie & Brinkman, 1988).

The literature suggests that productivity also holds value in understanding the formation of human capital, not as a direct causal agent, but for the role that productivity plays in creating income inequality. Human capital theory explains why higher wages are afforded to those with more education, in that differences in productivity that arise from education make the labor of educated workers more valuable than less educated workers (Becker, 1993; Hojo, 2003; Jorgenson & Fraumeni, 1993; Smith, 1976). However, little research has been performed to examine the relationship between productivity, income inequality, and the formation of human capital, specifically with regard to higher education.
Income Inequality

Income inequality refers to the distribution of income among members of a given population or economy. The relationship between income inequality and measures of human capital are well-established (Becker, 1993). Studies have examined not only the relationship between human capital and income inequality, but also the relationship between income inequality and public spending on education. These examinations have resulted in findings that support income inequality as both a cause and a result of the formation of human capital.

A study of the relationship between income inequality and government spending on student financial aid resulted in findings that support human capital theory. Hendel, Shapiro, and Willen (2005) found that increases in financial aid and reduced tuition for higher education were associated with greater income inequality. They reasoned that affordable tuition permits people with low financial resources and high ability to obtain higher education, thereby leaving only low ability people in unskilled employment, thus driving down the wages for unskilled workers.

Greenways and Hayes (2004) identify an absence of studies on the relationship between spending on higher education, the formation of human capital, and income inequality, but suggest a possible connection between these factors by noting that developed countries and developing countries are distinguished by the type education offered. That is, the critical factor in the distribution of income and the accumulation of wealth may be the level of education upon which money is spent and not simply education spending in general.

In the absence of state-level studies that focus on higher education spending, clues to the nature of the relationship between government spending on education and income inequality may be found in country-level studies of the relationship between spending on all types of education and income inequality. Such studies reveal that the relationship between government spending on education and subsequent levels of inequality is negative. Sylwester (2002) found that countries that devote a greater percentage of gross domestic product to public education have lower income inequality in subsequent years. Mayer (2001) concluded that higher levels of educational spending resulted in decreased levels of inequality in subsequent years.
Methods

Sampling Procedure

The unit of analysis for this study is the state. A sample of states was identified using extreme case sampling: a form of purposeful sampling that selects cases based on extreme manifestations of factors identified by the literature (Flyvbjerg, 2006; Patton, 1990). All 50 states were evaluated to identify states that demonstrated extreme instances of a set of factors that predicted economic growth. Extremes in income inequality and changes in productivity were used to select states that are examined in this study. The value that a sample of a few extreme cases holds over an analysis of all states is based on the idea that the extremes in factors may be useful in magnifying the effects of the factors. An analysis of all states could result in a homogenized description of the relationship between the factors such that the positive effects of a factor in one state are counteracted by the negative effects of the same factor in another state, thereby trading specificity of results for an unnecessary amount of generalizability. The use of extreme cases may be used to highlight important differences between states based on the selection factors, thereby permitting for greater use of results.

To achieve a sufficient number of observations, states were ordered by income inequality and changes in productivity and then divided into quintiles containing 10 states each. The highest and lowest quintiles for each group were then analyzed. The ordering of states was based on commonly recognized measures of income inequality and productivity using data obtained from national sources. Income inequality data, measured by the Gini coefficient, were obtained from the U.S. Census Bureau. Gini coefficients range from 0 to 1, where 0 represents complete income equality and 1 represents complete income inequality.

Productivity data, measured by per capita personal income, were obtained from the U. S. Bureau of Economic Analysis. In the absence of state-level indictors of output per hour, which are typically used to measure productivity at the national-level, per capita personal income is frequently used as a proxy for state productivity (Vedder, 2004a). At the same time, per capita personal income is also a measure of wealth, and therefore the ordering of states by changes in productivity by this measure also resulted in ordering states by changes in wealth. States included in the first and fifth quintile for income
inequality and changes in productivity, representing the least and most change respectively, are displayed in Table 7.

Given that the literature indicates that the expected relationship between the measure of productivity used here and income inequality on human capital is not strictly causal (Becker, 1993), it is inappropriate to place these factors in an equation with items that are expected to cause the formation of human capital. Yet, theoretical and empirical evidence suggests that these factors may offer additional information on the nature of the relationship between known factors such as tuition, financial aid, economic condition, as well as the less explored factor of state spending on higher education.

To these factors, this study adds a factor accounting for state spending on higher education. State and local appropriations for general operating expenses of public and independent higher education per capita is aimed at measuring state spending while controlling for state size. State spending on higher education has been the subject of previous studies that have identified that such spending is negatively associated with state economic growth (Vedder, 2004a, 2004b). Evidence of the relationship between state higher education spending and the formation of human capital is an essential factor in understanding the relationship between state spending higher education and economic growth (Williams & Swail, 2005).

The dependent variable for this study was human capital formation and was measured by enrollment rates. Enrollment were calculated using a method employed by Heller (1996, 1999) that divides total state enrollment in higher education by the state population age 18 to 24. As noted by Heller (1996), such a method assumes that the denominator represents the traditional but not the entire college-going population and acknowledges that the numerator includes students that fall outside of that age range. At the same time, this measure was a limitation of the study in that 18- to 24-year olds are not only college going population.

Data Collection

State-level data on fall undergraduate enrollment and undergraduate tuition at public and private non-profit and for-profit degree-granting colleges and universities were obtained from the Integrated Postsecondary Education Data System (IPEDS) that is administered by National Center for Educational Statistics of the Department of
Table 7
First and Fifth Quintiles for Income Inequality and Changes in Productivity, 1980-2005

<table>
<thead>
<tr>
<th>First Quintile</th>
<th>Fifth Quintile</th>
<th>Changes in Productivity</th>
<th>Fifth Quintile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alaska</td>
<td>Alaska</td>
<td>Connecticut</td>
<td>New Hampshire</td>
</tr>
<tr>
<td>Delaware</td>
<td>Alabama</td>
<td>Maryland</td>
<td>New Jersey</td>
</tr>
<tr>
<td>Iowa</td>
<td>California</td>
<td>Massachusetts</td>
<td>New York</td>
</tr>
<tr>
<td>Nebraska</td>
<td>Florida</td>
<td>Minnesota</td>
<td>North Dakota</td>
</tr>
<tr>
<td>Nevada</td>
<td>Kentucky</td>
<td>Montana</td>
<td>Rhode Island</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>Louisiana</td>
<td>Montana</td>
<td>Virginia</td>
</tr>
<tr>
<td>Utah</td>
<td>Mississippi</td>
<td>Ohio</td>
<td></td>
</tr>
<tr>
<td>Vermont</td>
<td>New York</td>
<td>Oklahoma</td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>Tennessee</td>
<td>Oregon</td>
<td></td>
</tr>
<tr>
<td>Wyoming</td>
<td>Texas</td>
<td>West Virginia</td>
<td></td>
</tr>
</tbody>
</table>
Education. State population data were obtained from the U.S. Census Bureau’s population estimate program. IPEDS enrollment data were not available in 1999 and state population data, broken out by the specified age range, were not available in 2001; therefore enrollment rate data were unable to be calculated for 1999 and 2001. Enrollment rates were calculated for all other years from 1980 to 2005.

Data for each of the variables were collected from national sources. Data on tuition were collected from IPEDS. Data on financial aid were collected from the National Association of State Student Grant and Aid Programs annual survey. Data on state unemployment rates were collected from the Bureau of Labor Statistics’ Local Area Unemployment Statistics database, which receives its data from the Census Bureau’s Current Population Survey. Data on state appropriations for higher education were collected from the State Higher Education Executive Officers annual State Higher Education Finance survey. In all cases, data were assembled and analyzed from 1980 to 2005, excluding years 1999 and 2001 in which enrollment rates are not available. As is common in time-series analysis, data that represent a monetary value, i.e. state spending, tuition, and grant aid, were indexed to a base year (Heller, 1997), in this case, 2006.

Data Analysis

Considering the factors identified by the literature and evidence from previous studies indicating that a cross-sectional analysis may fail to fully capture the complexity of the relationship between the independent variables and the dependent variable, this study applied a time-series analysis model to the data (Heller, 1999). A longitudinal analysis of time-series data permits for an examination of relationships over time, unlike a cross-sectional analysis (Box & Jenkins, 1970). For example, a longitudinal analysis of time-series data permits for the analysis of change in enrollment as a function of change in state spending. Moreover, longitudinal analysis of time-series data provides estimates of effects while eliminating the assumption that variables are independent. Therefore, a longitudinal analysis of time-series data more closely aligns with the research questions and the data to be analyzed.

The extent to which within state changes in spending on higher education can be used to predict within state changes in the formation of human capital will be tested by
using multivariate time-series procedures on independent variables that account for state higher education spending, tuition, financial aid, and unemployment, and the dependent variable accounting for formation of human capital.

To determine if changes in the continuous independent variables are useful in predicting changes in the continuous dependent variable, a multivariate time-series regression analysis procedure was performed for the highest and lowest state quintiles to determine the proportion of the variance in the formation of human capital that is predicted by state spending on higher education such that:

$$Y_{tj} = \beta_{\text{APPCAP}}x_{tj} + \beta_{\text{STUDFA}}x_{tj} + \beta_{\text{SPTUIT}}x_{tj} + \beta_{\text{PRTUIT}}x_{tj} + \beta_{\text{CPTUIT}}x_{tj} + \beta_{\text{UNEMP}}x_{tj} + c$$  \hspace{1cm} (8)

where Y is the 10-year change in the percent of each state’s total population enrolled in higher education, β is the beta values or regression coefficients for the 10-year change in state appropriations per capita for higher education (APPCAP), the 10-year change in state spending on student financial aid (STUDFA), the 10-year change in state average cost of tuition and fees at four-year public institutions of higher education (SPTUIT), the 10-year change in state average cost of tuition and fees at four-year private institutions of higher education (PRTUIT), the 10-year change in state average cost of tuition and fees at two-year public institutions of higher education (CPTUIT), and the 10-year change in state unemployment rate (UNEMP), all in year t and state j, and c is the constant where the regression line intercepts the Y axis.

Residual values, or variation from the regression line equation, calculated from the equation above were used to compute an $R^2$ value for each state’s equation. The $R^2$ value, or the coefficient of determination, was calculated by subtracting the residual value for each equation from 1. This value is used as an indicator of how well the model fit that data.

Results

Variation in Human Capital Formation by Extremes in Income Inequality

A portion of the independent variables were identified as significant predictors of the dependent variable for states that displayed with high and low income inequality. For those states with high income inequality, change in state higher education spending was not a significant predictor of change in enrollment rate. For states with low income inequality, change in state higher education spending was a significant positive predictor
of change in enrollment rate. Table 8 summarizes the beta values for each of the independent variables and identifies those variables that were significant in predicting change in enrollment rates.

Analysis of data from states with low income inequality, i.e., those in the first income inequality quintile, revealed that state spending on higher education (APPCAP), state spending on student financial aid (STUDFA), tuition and fees at four-year public institutions (SPTUIT), and state unemployment rate (UNEMP) were each significant predictors of change in enrollment rates. Of these variables, state spending on higher education, tuition and fees at four-year public institutions and state unemployment rate conformed to the direction predicted by the literature, in that state spending on higher education and state unemployment rate were each positive predictors of enrollment rate change. Tuition and fees at four-year public institutions was a negative predictor of enrollment rate change. The direction of the relationship between state spending on student financial aid and enrollment rate change differs from the direction predicted by Leslie and Brinkman (1988) in that the findings here reflect an inverse relationship between spending on grant aid and enrollment rates, though this study did not use the unit of analysis that was most prevalent in the studies analyzed by Leslie and Brinkman.

Analysis of data from states with high income inequality, i.e., those in the fifth income inequality quintile, revealed that only state unemployment rate was a significant predictor of change in enrollment rates and that the relationship between the two was negative. This finding is contrary to the direction of the relationship predicted by the literature. The analysis of this data did not identify a significant relationship between state spending on higher education and change in enrollment rates.

Multiple R values and coefficients of determination were calculated for states in the first and fifth quintile of income inequality to determine if the data fit the model. The multiple R value for the analysis of the first quintile was 0.463 and the coefficient of determination, or R², was 0.215. The analysis of the fifth quintile resulted in a multiple R of 0.300 and R² of 0.090.

Variation in Human Capital Formation by Extremes in Productivity Change

A portion of the independent variables were identified as significant predictors of the dependent variable for states that displayed high and low growth in productivity. For
Table 8

*Predictors of Enrollment Change in Low and High Income Inequality States*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low Income Inequality States</th>
<th></th>
<th>High Income Inequality States</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standardized β coefficient</td>
<td>t-Value</td>
<td>Standardized β coefficient</td>
<td>t-Value</td>
</tr>
<tr>
<td>APPCAP</td>
<td>0.219</td>
<td>2.535*</td>
<td>0.162</td>
<td>2.064</td>
</tr>
<tr>
<td>STUDFA</td>
<td>-0.328</td>
<td>-3.911*</td>
<td>-0.053</td>
<td>-0.609</td>
</tr>
<tr>
<td>SPTUIT</td>
<td>-0.313</td>
<td>-3.651*</td>
<td>-0.004</td>
<td>0.046</td>
</tr>
<tr>
<td>PRTUIT</td>
<td>-0.013</td>
<td>-0.143</td>
<td>-0.030</td>
<td>-0.350</td>
</tr>
<tr>
<td>CPTUIT</td>
<td>0.053</td>
<td>0.623</td>
<td>0.021</td>
<td>0.025</td>
</tr>
<tr>
<td>UNEMP</td>
<td>0.188</td>
<td>2.128*</td>
<td>-0.288</td>
<td>-2.689*</td>
</tr>
</tbody>
</table>

* α ≥ .05
states with low productivity growth, change in state higher education spending was a significant positive predictor of change in enrollment rate. For those states with high growth in productivity, change in state higher education spending was a negative predictor of change in enrollment rate. Table 9 summarizes the beta values for each of the independent variables and identifies those variables that were significant in predicting change in enrollment rates.

Analysis of data from states with low productivity growth, i.e., those in the first productivity growth quintile, revealed that state spending on higher education, state spending on student financial aid, tuition and fees at two-year public institutions (CPTUIT) and state unemployment rates were each significant predictors of change in enrollment rates. Of these variables, only state spending on higher education conformed to the direction predicted by the literature, in that state spending on higher education was a positive predictor of enrollment rate change. The direction of the relationship between the other significant variables and enrollment rate change differ, at least in part, from that predicted by the literature, in that most of the previous studies have found that increases in student financial aid increase enrollment, increases in tuition decrease enrollment, and increases in unemployment increase enrollment.

Analysis of data from states with high productivity growth, i.e., those in the fifth productivity growth quintile, revealed that state spending on higher education, tuition and fees at four-year public institutions, and tuition and fees at two-year public institutions were each significant predictors of change in enrollment rates. The variable tuition and fees at four-year public institutions negatively predicted change in enrollment rates as identified by the literature. Tuition and fees at two-year public institutions positively predicted change in enrollment rates. This relationship is consistent with the findings of Rouse (1994) who found that the relationship between tuition increases and enrollment at public, two-year colleges can be positive if tuition increases at public-four year institutions at the same time.

The direction of the significant relationship between state spending on higher education and enrollment rate growth in states comprising the fifth productivity growth quintile was negative. This negative relationship is both contrary to the direction
Table 9

*Predictors of Enrollment Change in Low and High Productivity Growth States*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low Productivity Growth States</th>
<th>High Productivity Growth States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standardized β coefficient</td>
<td>t-Value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APPCAP</td>
<td>0.301</td>
<td>4.138*</td>
</tr>
<tr>
<td>STUDFA</td>
<td>-0.158</td>
<td>-2.226*</td>
</tr>
<tr>
<td>SPTUIT</td>
<td>-0.012</td>
<td>-0.156</td>
</tr>
<tr>
<td>PRTUIT</td>
<td>-0.073</td>
<td>-1.064</td>
</tr>
<tr>
<td>CPTUIT</td>
<td>0.294</td>
<td>4.337*</td>
</tr>
<tr>
<td>UNEMP</td>
<td>-0.347</td>
<td>-4.909*</td>
</tr>
</tbody>
</table>

* α ≥ .05
identified by the literature and the direction of the relationship observed in the first productivity growth quintile.

Multiple R values and coefficients of determination were calculated for states in the first and fifth quintile of productivity growth to determine if the data fit the model. The multiple R value for the first quintile was 0.619 and the coefficient of determination, or $R^2$, was 0.383. The fifth quintile had a multiple R of 0.493 and $R^2$ of 0.293. Both coefficient of determination values are indicative of moderate strength of relationships (Cohen, 1988).

In each of the analyses, steps were taken to identify violations of the assumptions of regression equations and to determine how well the data fit the model. Durbin-Watson statistics (Durbin & Watson, 1951) ranging from 1.77 to 1.93 were computed to test for first-order autocorrelation in the analyses of states in the first and fifth quintile of income equality and growth in productivity. Such values are not indicative of a problem with autocorrelation. Tolerance and variance inflation factors were computed for the data and neither set of factors were indicative of a problem with multicollinearity. Leverage statistics, Cook’s distance, and df Betas were also normal, indicating that none of the individual data points were outside the general linear pattern.

Discussion

The results of this study show that increases in state higher education spending do not predict increases in the formation of human capital in all states. By regressing state spending and enrollment rates for states grouped by (a) productivity and (b) income inequality, rather than one set of all states, it becomes clear that the relationship between state spending and enrollment rates is not the same for all states. This analysis leads to the conclusion that some states benefit from state higher education spending while others may not. States with low growth in productivity and wealth, and states with low levels of income inequality appear to benefit from state higher education spending in the form of enrollment rate growth. Enrollment rate appears deterred by state higher education spending in states with higher productivity growth. And for states with high income inequality, increases in state higher education spending appear to have no relationship with enrollment rates.
In an analysis of states segregated by changes in productivity, data for those states that comprise the first productivity quintile demonstrate a positive relationship between changes in state spending on higher education and changes in enrollment rates while data for those states in the fifth productivity quintile demonstrate a negative relationship between the same variables. This finding suggests that increases in spending on higher education result in increases in the formation of human capital for those states that demonstrate low growth in productivity, while decreases in state spending result in increases in the formation of human capital for those states with high productivity growth.

This relationship is consistent with previous findings while suggesting the existence of a more complex relationship than has been examined previously. Human capital theory identifies that increases in the stock of human capital cause increases in productivity. This study, to overcome the methodological obstacles brought on by lag-time and interstate migration, used a flow measure of human capital rather than a stock measure. The flow measure of human capital used here (i.e., state enrollment rate) has been identified by previous studies as a function of the measure of productivity used here (i.e., personal income) as well as a cause. Studies have identified that more productive and wealthier countries, as measured by personal income and gross domestic product per capita, have higher educational attainment rates than countries that are less productive and less wealthy (Hsing, 2005; Thomas, et al., 2001).

The findings here indicate that (a) change in state higher education spending negatively predicts change in the formation of human capital among states with rapid productivity and wealth growth, and (b) the converse is true among states with low productivity and wealth growth. These findings suggest that some other interaction may be at play. Conceivably, states with low level increases in productivity and wealth may require the catalyst of state higher education spending to increase human capital formation, while states with high levels of productivity and wealth growth may respond to increases in state spending as an inhibitor of human capital formation as such increases in spending may, as Vedder (2004a, 2004b) identified, be unnecessary.

The findings here suggest that there may be a threshold at which state spending is not productive in increasing the formation of human capital. While Vedder (2004a)
reached the conclusion that state spending on higher education was an unnecessary drag on the economy, the findings here suggest that state spending on higher education is useful in increasing the formation of human capital in those states with low productivity and wealth growth. States with high productivity and wealth growth do not appear to benefit from additional state spending on higher education in the same way and therefore give conditional support to Vedder's (2004a) findings. The results of the analysis suggest that enrollment rates in these states may be increased by specifically reducing tuition at public four-year institutions rather than increasing spending for higher education generally, as tuition at these institutions negatively predicted human capital formation.

In a longitudinal analysis of states segregated by income inequality, changes in state higher education spending for those states that comprise the first income inequality quintile positively predict changes in the formation of human capital, while no significant relationship exists in fifth quintile between increases in state spending and enrollment rates. This finding suggests that states with low income inequality benefit from state spending on higher education in the form of increased human capital formation. Furthermore, this finding appears to align with the longitudinal findings of Sylwester (2002) and Mayer (2001) who each found that government spending on education was negatively related to income inequality.

The finding that changes in student financial aid spending negatively predict enrollment rate change in low inequality states appears to stand in contrast to most of the previous studies on student financial aid (Heller, 1999; Leslie & Brinkman, 1988). The reason for this unusual finding may be the result of the data set used to proxy financial aid spending, the unit of analysis examined in this study or the finding may, in fact, signal a relationship that exists among states with low income inequality with regard to financial aid spending and human capital formation. The data used in this study account only for state spending on grants, thereby failing to account for state spending on other forms of financial aid. These other forms of financial aid may be a key element in the relationship between financial aid and human capital formation. Findings from previous studies that indicated a positive relationship between financial aid and enrollment were primarily focused on the individual as the unit of analysis (Leslie & Brinkman, 1988), rather than on the state as was the case in this study. In addition, it is possible that states
with greater equality do not benefit from state spending on financial aid. Such a conclusion would be consistent with the findings of Hendel et al. (2005) who identified that greater financial aid spending, coupled with lower tuition, resulted in greater income equality in subsequent years. By examining states with the greatest equality of income, one might expect to find that state spending on financial aid has at least no effect on enrollment rates while not ruling out that state spending on financial aid has a negative effect on enrollment rates in these states.

The finding that changes in unemployment negatively predict enrollment rate change in states with higher income inequality appears to stand in contrast with previous studies on the relationship between enrollment rates and unemployment. The discrepancy here may be a function of high income inequality, as the same relationship was not observed in states with low income inequality. Unemployment appears to inhibit, rather than promote human capital formation in states with high income inequality.

In total, the results of this study indicate that some states benefit from increases in state higher education spending while others may not. Those states that appear to benefit, in the form of human capital formation, from state spending on higher education are those states with lower levels of income inequality and those states with lower rates of productivity growth. Increases in state spending on higher education in states with higher levels of income inequality appear to be detrimental to the formation of human capital.
REFERENCES
References marked with an asterisk indicate studies included in a meta-analysis.


Economic Letters, 6, 81-88.

on economic growth. *Contemporary Economic Policy, 24*(1) 18-34.

Review, 45*(1) 1-28.


Macunovich, D. J., (1997). Will there be a boom in the demand for U.S. higher education


Mayer, S. E. (2001). How did the increase in economic inequality between 1970 and

growth? In W. E. Becker & D. R. Lewis (Eds.) *Higher Education and Economic

and economic growth analysis: Note. *Growth and Change, 19*(1), 61-66.


Evidence from the United States and United Kingdom. *Journal of Public
Economics, 88*, 1667-1795.


Webber, D. J. (2002). Policies to stimulate growth: Should we invest in health or education? Applied Economics, 34, 1633-44.


