Higher Education and State Workforce Productivity in the 1990s[1]

by Nasrin Fatima and Michael B. Paulsen

A state's initial cumulative investment in higher education made in 1990, we have found in a recent study, had a direct, positive effect on subsequent growth in state workforce productivity from 1990 to 1999. Given this evidence of the substantial public benefits of higher education, perhaps it is finally time to reconsider the importance of public investment in higher education.

Based on our findings, we argue that state budgets for higher education—which have long-term consequences in terms of both private and public benefits and the well-being of society—should not be based on quick reactions to short-term fluctuations of the business cycle. Instead, state budgets for higher education should be carefully planned and calculated to maximize public benefits per dollar spent for the state's population.[2]

Investment in higher education yields two types of benefits.[3] Private benefits, such as differences in earnings between college and high school graduates, accrue primarily to those students acquiring the education.[4]

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Public benefits, such as increases in the overall productivity of a state's workforce, accrue to members of society beyond those students, adding to everyone's income rather than only to the incomes of those investing in higher education.[5,6]

Consistent with this mix of private and public benefits, postsecondary education is financed with funds from a mix of private (the student) and public (society) sources.[7] One of the key economic principles used to inform decisions about who should bear the cost of a student's education, the student or society, shows variance depending on the relative shares of private and public benefits associated with that education.[8,9] The perennial question "Who receives more of the benefits of an investment in education, the individual student or society?" has been the centerpiece of a long-standing and ongoing debate.[10]

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In the United States, judgments about the private-public mix of benefits, which are subject to change over time, are ultimately made by citizens and their elected representatives through the political process, with such judgments reflected in policies related to educational finance. In this manner, Americans have consistently demonstrated their conviction that the public benefits of education from kindergarten through the 12th grade are so important that society insists on compulsory schooling up to a certain age and is willing to be taxed to provide public schools with funding sufficient to cover all the costs of educating students. In other words, Americans demonstrably believe that the private benefits of such educational investment are dwarfed by the public benefits, and therefore choose to provide free public education through the 12th grade.

But between the 12th grade and the college years, the judgments of American citizens and their elected representatives appear to abruptly change, yielding a much weaker, and continuously weakening, confidence in the public benefits of education. A prominent indicator of this pattern can be seen in the decisions of state legislatures regarding appropriations for higher education (the largest discretionary component in state budgets) and funding for more politically compelling commitments to fund Medicaid, corrections, and K–12 education.[11,12] For example, the portion of revenues of public colleges and universities Americans have been willing to provide through taxation and state appropriations has diminished over a 20-year period from 44 percent in 1980–81 to only

32.3 percent in 1999–2000,[13] thereafter continuing to account for less than a third of current fund revenues.[14,15] At the same time, the portion of public universities' costs borne by students in the form of tuition has increased from 12.9 percent of current revenues in 1980–81 to 18.6 percent of current revenues in 1999–2000.[16,17,18]

These trends have continued, and even accelerated, in the early 2000s. State revenue shortfalls, budget-balancing restrictions, the requisite funding of entitlements, and the unpopularity of tax increases have led to slow growth, no growth, mid-year rescissions, and outright reductions in state appropriations for public colleges and universities.[19] In fact, after adjustment for inflation, more than half the states reduced their appropriations to public institutions between fiscal years 2001 and 2003.[20] [21] While, between academic years 2000–01 and 2002–03, tuition at public four-year institutions increased by 17.0 percent before and 13.8 percent after inflation is considered.[22,23]

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These substantial and sweeping changes in policy regarding the finance of higher education appear to have taken place with relatively little attention to research, policy analysis, or discussion and debate about the public benefits of investment in higher education.[24] But the recession of the early 2000s has provided a fertile context for such important discussion and debate by intensifying the challenge to justify society's investment in postsecondary education in state legislatures and governors' offices.

The justification for increasing state investment in public universities depends, in large part, on providing evidence of the public benefits of such state investments. If it can be demonstrated that substantial public benefits accrue from investment in higher education—benefits not captured by individual investors but dispersed among the members of society in general—then greater public expenditure on higher education can be justified.[25]

The public benefits of investment in higher education have been identified, examined, and estimated in a number of ways: 1) by calculating social rates of return that are substantial, significant, and compare favorably with rates of return on investments in alternative interest-earning assets;[26] 2) by documenting the value of a wide variety of nonmonetary public benefits;[27] 3) by conducting numerous studies of the impacts of

higher education institutions on local, state, or regional economic activity;[28] and 4) by demonstrating the substantial contribution of higher education to growth in the U.S. economy.[29] Unfortunately, because many of the public benefits of higher education are intangible, measuring the magnitude of public benefits is often problematic; also, the number of studies of such public benefits has diminished substantially in recent years.[30]

In this article, we attempt to expand existing perspectives on the nature and magnitude of social gains resulting from public education investment by presenting new quantitative evidence of tangible benefits, evidence based on the results of our study of the effects of such investments on growth in state workforce productivity in the 50 states and the District of Columbia during the 1990s. Our findings clearly support those of a similar, previous study based on 1980s data.[31] We conclude with a discussion of the policy implications of the study's results and present technical material in an appendix.

Because many of the public benefits of higher education are intangible, measuring the magnitude of public benefits is often problematic.

Research has consistently shown that cumulative investments in higher education have a positive effect on the subsequent growth in the economies of various sets of countries,[32] and a previous study of state workforce productivity in the 1980s found that cumulative investments in higher education had a positive effect on the subsequent growth in the workforce productivity of America's individual state economies.[33] The study presented here is informed by and grounded in this previous research and follows the recommendation of Pencavel[34] for more studies that examine cross-sections of economies to assess the relationship between educational attainment of the labor force and economic growth.

Our study estimates the effects of cumulative investments in higher education on the subsequent growth in workforce productivity in the individual state economies of the United States. Increases in the overall productivity of a state's workforce due to cumulative investments in the higher education of its workforce would constitute an unambiguous public or social benefit. Such increases in the productivity of a state's labor force should result in higher average incomes for everyone, rather than for only those investing in higher education.[35]

More specifically, this study examines such effects of cumulative investments in higher education on subsequent growth in state work-

force productivity. The study controls for the effects of a state's initial workforce productivity measured at the beginning of the period of analysis of growth, and for the effects of economic expansions and contractions in various industries in the national economy that can differentially affect economic activity in individual state economies.

Table 1 (page 90)displays the values of the dependent and independent variables examined in the study for the 50 states and the District of Columbia.

The second column presents the values of the dependent variable in the study, the percentage growth in each state's workforce productivity between 1990 and 1999 **($GROWTH_{99/90}$)**, which measures the percent change in the gross state product divided by the state's labor force.[36]

Investments in higher education had a positive effect on the subsequent growth in the workforce productivity of America's individual state economies.

The third column presents the values of the first of the independent variables—a state's initial level of workforce productivity, measured as gross state product per worker—which represents each state's workforce productivity at the beginning of the period of analysis in 1990 **($PROD_{90}$)**.

The fourth column displays the values of the second independent variable—a state's initial cumulative investment in higher education at the beginning of the period of analysis in 1990 **($HIGHED_{90}$)**—which is measured as the percent of all high school graduates age 25 and over in each state who were also college graduates.

The fifth column presents the values of the third independent variable, the percentage expansion (or contraction) in a state's economic activity **($ECONACT_{99/90}$)** during the period of analysis, measured as the weighted average of the percentages of growth or decline in the total gross domestic product per capita of the nation, originating from each of 10 distinct industries between 1990 and 1999.

These weights represent the shares of each state's gross state product that originates from each of the 10 separate industrial sectors.[37] Finally, the bottom row of figures in Table 1 presents the average values for the dependent and independent variables for the entire sample of 50 states and the District of Columbia.[38]

TABLE 1
Higher Education and Growth in Workforce Productivity:
The 50 States and the District of Columbia

State	Growth	Prod	Highed	Econact
AL	0.157	43890	0.235	0.192
AK	-0.142	94857	0.266	0.129
AZ	0.274	45056	0.258	0.193
AR	0.227	40965	0.201	0.201
CA	0.162	60776	0.307	0.199
CO	0.280	49110	0.319	0.191
CT	0.279	65016	0.343	0.209
DE	0.150	70542	0.237	0.202
DC	0.185	152802	0.455	0.118
FL	0.164	48450	0.246	0.198
GA	0.260	49186	0.272	0.206
HI	0.015	63346	0.286	0.176
ID	0.218	41828	0.221	0.191
IL	0.212	54428	0.276	0.210
IN	0.231	45372	0.206	0.206
IA	0.168	45122	0.210	0.202
KS	0.132	47678	0.260	0.199
KY	0.190	45123	0.211	0.195
LA	0.038	58392	0.236	0.177
ME	0.076	44545	0.238	0.194
MD	0.138	51935	0.337	0.184
MA	0.292	57396	0.340	0.204
MI	0.152	49421	0.226	0.205
MN	0.206	50404	0.265	0.205
MS	0.213	39389	0.229	0.193
MO	0.169	48314	0.241	0.207
MT	0.037	40551	0.244	0.182
NE	0.190	47410	0.232	0.194
NV	0.194	56486	0.194	0.185
NH	0.388	44302	0.297	0.206
NJ	0.199	61422	0.324	0.209
NM	0.419	42106	0.272	0.170
NY	0.222	65724	0.309	0.202
NC	0.296	46218	0.248	0.202
ND	0.162	42118	0.236	0.185
OH	0.190	50197	0.224	0.206
OK	0.145	44114	0.239	0.182
OR	0.282	47174	0.253	0.202
PA	0.195	50281	0.240	0.204
RI	0.232	48191	0.295	0.197
SC	0.190	43143	0.244	0.191
SD	0.188	44208	0.223	0.191
TN	0.233	45435	0.238	0.204
TX	0.218	52647	0.282	0.191
UT	0.173	46302	0.262	0.183
VT	0.104	44512	0.301	0.200
VA	0.201	52272	0.326	0.178
WA	0.163	54930	0.274	0.197
WV	0.114	42679	0.187	0.190
WI	0.201	45699	0.226	0.204
WY	0.026	63880	0.226	0.145
AVERAGE	**0.184**	**52654**	**0.261**	**0.192**

Note: Averages may not be consistent with figures in table due to rounding.

Multiple regression analysis was used to estimate the effects of these three independent variables—initial workforce productivity, initial cumulative investment in higher education, and economic activity in the state economies—on the dependent variable, growth in state workforce productivity between 1990 and 1999; and to test three hypotheses about these relationships.

First, based on previous research on the relationship between investment in higher education and growth in both national and state economies,[39] a state's initial cumulative investment in higher education was expected to have a positive effect on subsequent growth in workforce productivity.

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Second, research on convergence theory has shown that among a group of otherwise similar economies, those with lower levels of workforce productivity at the beginning of a period of analysis tend to experience greater subsequent economic growth, as they "catch up" by adopting, adapting, and implementing the techniques and approaches of their initially more productive counterparts.[40] Therefore, a state's initial workforce productivity was expected to have a negative effect on subsequent growth in its workforce productivity.

Third, research has shown that expansions or contractions in various industries of the national economy can enhance or restrict economic activity in state economies. More specifically, those states whose economies depend more heavily on industries that experience substantial expansion in the national economy tend to experience greater economic growth and increased productivity during a given period of analysis, all else being equal.[41] Therefore, economic expansion in a state's economy was expected to have a positive effect on growth in a state's workforce productivity. The technical appendix presents more detail about the dependent and independent variables, data sources, statistical analyses, assumptions, and potential limitations of the study.

The results of the study indicate that both initial cumulative investment in higher education and expansion in economic activity in state economies had positive and statistically significant effects on growth in state workforce productivity between 1990 and 1999, and that while the estimated effect of a state's initial workforce productivity on subsequent growth in its workforce productivity had the expected negative result, it

was not statistically significant. First, the central research question for this study was "What was the effect of the initial (1990) cumulative investment in higher education in state economies on the subsequent growth in state workforce productivity between 1990 and 1999?" The results indicate that investment in higher education had significant and substantial positive effects (t=2.95, p=.0049) on growth in state workforce productivity; the magnitude of the coefficient was 0.88. A meaningful and useful way to interpret these results is to note that the average value of cumulative investment in the higher education of a state's workforce in 1990 was .261 or 26.1 percent (see **HIGHED** in Table 1). Therefore, all else being equal, for an otherwise average state, each 10 percent increase in the average value of initial cumulative investment in higher education (0.261 x .10 = .0261) was associated with a 2.3 percent increase in subsequent growth in the state's workforce productivity (0.88 x .0261 = .0230 or 2.3 percent).

An example from Table 1 can illustrate this effect. Colorado and Florida had very similar values for initial workforce productivity (see **PROD** in Table 1), 49,110 and 48,450—and expansion in economic activity (see **ECONACT** in Table 1), .191 and .198. However, Colorado had a substantially greater level of initial cumulative investment in higher education (see **HIGHED** in Table 1) than Florida did—.319 compared with .246. Therefore, as expected, the state of Colorado experienced much greater growth in its workforce productivity (see **GROWTH** in Table 1) from 1990 to 1999 than did Florida—.280 compared with .164.

Second, those states in which economic activity was more heavily

weighted in industrial sectors benefitting from expansion in the national economy experienced greater growth in workforce productivity than other states between 1990 and 1999. The findings indicate that expansion in a state's economic activity had a significant and positive effect on subsequent growth in the state's workforce productivity (t=2.64, p=.0113) and the magnitude of the coefficient was 2.12.

A useful way to interpret these results is to note that the average value of expansion in state economic activity (see **ECONACT** in Table 1) between 1990 and 1999 was 0.192 or 19.2 percent. Therefore, for an otherwise average state, each 10 percent increase in the average value of expansion in a state's economic activity (0.192 x .10 = .0192 percentage points) was associated with a 4.1 percent increase in the growth in a state's workforce productivity (2.12 x .0192 = .0407 or 4.1).

The most important finding is that investment in higher education had a direct, positive effect on growth in state workforce productivity.

An example from Table 1 can illustrate this effect as well. Oregon and Utah had very similar values for initial workforce productivity (47,174 and 46,302) and initial cumulative investment in higher education (.253 and .262). However, economic activity in Oregon benefitted more than did economic activity in Utah from expansion in various industrial sectors in the national economy between 1990 and 1999—.202 compared with .183.[42] So as expected, Oregon experienced greater growth in its workforce productivity from 1990 to 1999 than Utah did—.282 compared with .173.[43]

The most important finding of this study is that investment in higher education had a direct, positive effect, of both statistical significance and substantial magnitude, on growth in state workforce productivity during the 1990s. This result is consistent with the findings of previous research using gross state product data for the 1980s,[44] (previous studies using international data on diverse samples of national economies),[45] and with the predictions of human capital theory regarding the anticipated effects of investments in higher education on economic growth and productivity.[46]

There are several ways of expressing and demonstrating the impressive magnitude of this study's estimate of the effects of investment in higher education on growth in state workforce productivity. First, findings indicate that, all else being equal, each percentage point increase in a state's investment in higher education in 1990 was associated with a .88 per-

centage point increase in a state's rate of growth in workforce productivity between 1990 and 1999.[47] Second, the average growth in state's workforce productivity for all 50 states was .184 or 18.4 percent. As a result, each percentage point increase in the investment in higher education for an otherwise average state would raise the subsequent nine-year growth in that state's workforce productivity by 4.8 percent (.88/18.4 = .0478). Third, many states might increase their investment in higher education by much more than just one percentage point. Suppose an otherwise average state were to increase its investment in higher education by 10 percent. Given the magnitude of the effect of investment in higher education on workforce productivity estimated in this study, this would mean that each 10 percentage points by which an otherwise average state increased its investment would raise the subsequent nine-year growth in that state's workforce productivity by 48 percent (8.8/18.4 = .4783).

Too often, higher education becomes the most politically accessible target for cuts in state budgets.

The impressive magnitude of the effect of higher education investment on growth in state workforce productivity found in this study indicates the existence of substantial public benefits of such investments. It provides compelling quantitative evidence of an unambiguous public or social benefit of such investment, strongly supporting the persistent argument to justify increased public investment in higher education.

Furthermore, this new evidence strengthens the argument for public investment by supplementing other evidence of the public benefits of investment in higher education, including impressive social rates of return, the value of nonmonetary public benefits, the economic impacts of higher education institutions, and the contribution of higher education to national economic growth.

The many and substantial public benefits of higher education raise questions about how we should conceptualize public finance policy in our states. During periods of state revenue shortfalls, and because of increased sensitivity to the challenges of state budget-balancing restrictions, the improbability of passing unpopular state tax increases, and the required state funding of entitlements such as Medicaid, corrections, and K–12 education, legislators and governors too often seek budgetary relief in that biggest discretionary component of most state budgets: appropriations for higher education.

Unfortunately, there are also cyclical patterns that signal a persistent

worsening of these problems. For example, in the recessions of the early 1980s, early 1990s, and now the early 2000s, state appropriations for higher education per $1,000 of state personal income have fallen considerably.[48] Potentially even more troubling is that during periods of economic recovery *after* the recessions of the early 1980s and 1990s, the states provided relatively little compensatory catch-up funding for higher education; and thus far, state legislatures have given the higher education community little reason to expect much compensatory catch-up funding during the current economic recovery.[49]

Finally, the loss of both private and public benefits arising from cutbacks in public support for higher education, and the effects of such cutbacks on the affordability of college and the capacity to provide adequate enrollment places, will only intensify in the face of a demographic environment that will swell the ranks of college students.

These trends are truly problematic for the higher education enterprise, and in terms of the findings of this study, cuts in appropriations constitute reductions in public investment in higher education which, in turn, can constrain or slow down the growth in the educational attainment of a state's labor force and lead to a minimization or reduction in a state economy's potential for growth in workforce productivity.

TECHNICAL APPENDIX

This study estimates the effect of cumulative investment in higher education in 1990 on subsequent growth in state workforce productivity between 1990 and 1999, while controlling for the effects of initial workforce productivity in 1990 and of expansion in the national economy on economic activity in individual states between 1990 and 1999. Toward this end, we used multiple regression analysis to estimate the coefficients of Equation 1 below, using cross-section data on all 50 states and the District of Columbia.

$$\mathbf{GROWTH}_{99/90i} = b_0 + b_1\mathbf{PROD}_{90i} + b_2\mathbf{HIGHED}_{90i} + b_3\mathbf{ECONACT}_{99/90ij} \quad \text{(Eq. 1)}[50]$$

where i = 1 ……51 states, j = 1…10 industries in national and state economies, and $\mathbf{GROWTH}_{99/90i}$ = growth in workforce productivity from 1990 to 1999 in state i, measured as the percent change in workforce productivity, i.e., the inflation-adjusted gross state product divided by the number of individuals in the labor force, age 16 years and over, between 1990 and 1999.

$\mathbf{PROD}_{90i}$ = the initial level of workforce productivity in state i in 1990, measured as the inflation-adjusted gross state product divided by the size of the total labor force in state i at the beginning of the period of analysis. The variable **PROD** controls for the effects of a wide range of factors

other than cumulative investments in higher education that worked, in combination, to determine the level of workforce productivity in each state in 1990—the beginning of the nine-year period of analysis.[51,52]

HIGHED$_{90i}$ = cumulative investment in higher education in 1990 in state i, measured as the number of high school graduates, age 25 and over, who had bachelor's degrees, divided by the total number of high school graduates age 25 and over in 1990 (at the beginning of the nine-year period of analysis) in state i. This measure of cumulative investment in the higher education of the workforce for each state in 1990 accounts for the net migration of college graduates between states that have occurred up to the first year of the period of analysis.[53]

ECONACT$_{99/90ij}$ = percent expansion or contraction in economic activity in state i from 1990 to 1999. Aggregate disturbances or shocks (expansions or contractions) in economic activity of various industries on the national level can have differential effects on the gross state products of individual state economies, depending on differences in the industrial compositions of state economies.[54] Because of the importance of estimating and controlling for these effects, a complex and comprehensive measure of economic activity was constructed.[55] This measure captures the subtle patterns of changes in economic activity in each of 10 industries that contribute to the nation's gross state product and to each state's gross state product and its growth during the period of analysis. For state i, the variable **ECONACT** below was calculated as follows:

$$\textbf{ECONACT} = \sum_{j=1}^{10} W_{ijt} \cdot \log\left[\frac{Y_{jt+T}}{Y_{jt}}\right] \qquad \text{(Eq. 2)}$$

where i = 1…51 states, j = 1…10 industrial sectors,[56] and t = 1…9 years; t is the initial year of the period of analysis (1990), and T is the final year of the growth period, which extends from 1990 to 1999, i.e., T = t + 9 = 1999. Y_{jt} is the total gross state product per capita for the national economy originating in sector j at time t (1990), Y_{jt+T} is the total gross state product per capita for the national economy originating in sector j at time t + T (1999), and log $[Y_{jt+T}/ Y_{jt}]$ is the percentage change in total gross state product per capita for the national economy originating in sector j between time t (1990) and time T (1999). Finally, W_{ijt} is the weight of industrial sector j in state i's gross product at time t, 1990. Therefore, combining all these elements, as expressed in Equation 2 above, this variable represents the weighted average of the percentages of growth or decline in the gross state product of the national economy originating from each of 10 distinct industries, where the weights represent the shares of each state's gross state product originating in each of the 10 industries.[57,58]

$\mathbf{b_0}$ = a constant that is the net effect on growth of state workforce productivity due to other influences that are not specified or controlled for in the equation.

$\mathbf{b_1}$ = the effect on state workforce productivity growth **(GROWTH)** due to an increase of one-unit in **PROD**, ceteris paribus (expected relationship: $\mathbf{b_1} < 0$).

$\mathbf{b_2}$ = the effect on state's workforce productivity growth **(GROWTH)** of a one-unit increase in the **HIGHED** variable, ceteris paribus, in the year 1990 (expected relationship: $\mathbf{b_2} > 0$).

$\mathbf{b_3}$ = the effect on workforce productivity growth **(GROWTH)** due to an increase of one unit in **ECONACT**, ceteris paribus (expected relationship: $\mathbf{b_3} > 0$).

Estimated coefficients for Equation (1) are presented below,[59] with the mean values of the dependent and independent variables appearing in brackets above each variable's name, and the p-values indicating the statistical significance of each t-test appearing in parentheses below each estimated regression coefficient.

$$\underset{}{\overset{[.184]}{\mathbf{GROWTH}_{99/90i}}} = \underset{}{-.377} + \underset{(.044)}{\overset{[52{,}654]}{-.000001}}\mathbf{*PROD}_{90i} + \underset{(.005)}{\overset{[.261]}{.880}}\mathbf{*HIGHED}_{90i} + \underset{(.011)}{\overset{[.192]}{2.12}}\mathbf{*ECONACT}_{99/90ij}$$

$R^2 = .35 \qquad (.191)$

In summary, the initial cumulative level of investment in the higher education of a state's workforce in 1990 had a substantial positive effect, of both statistical and practical significance, on subsequent growth in a state's workforce productivity between 1990 and 1999. In addition, expansions in the economic activity of various industries in state economies had a substantial and positive effect on growth in state workforce productivity. However, even though the initial level of the state's workforce productivity had a negative effect on subsequent growth in that productivity, the effect was not statistically significant. Therefore, the effects of **HIGHED** and **ECONACT** on growth were consistent with the hypothesized relationships.

ENDNOTES

1 An earlier version of this paper was presented at the annual meeting of the Association for the Study of Higher Education, Sacramento, California, November 2002.

2 Patrick M. Callan and Joni E. Finney of the California Higher Education Policy Center began their book, *Public and Private Financing of Higher Education*, with the following insightful overview of developments in the finance of higher education since 1980: "The financing and accessibility of higher education are major issues of social and educational policy. Yet it would be difficult to identify a public policy area that has undergone as much change with as little public discussion or explicit policy direction as the financing of American higher education in recent years. The respective responsibilities of students, families, colleges and universities, and government have altered significantly, but with little debate, and without any public policy consensus" (Callan and Finney, 1997, xi).

[3] Berger, 1992; Cohn and Geske, 1990; Paulsen, 2001a; Solmon and Fagnano, 1995.

[4] W. Becker, 1992; College Board, 2002a; Murphy and Welch, 1989; Paulsen, 1998; Paulsen and Pogue, 1988.

[5] Baumol, et al., 1989; Bowen, 1977; Paulsen, 1996a, 1996b, 2001b; Wolfe, 1995.

[6] In accordance with the principles of human capital theory, college graduates are likely to increase not only their own productivity, but the productivity of their co-workers, employers, or employees, and the productivity of physical capital, i.e., the equipment and structures with which they work, through their enhanced knowledge and skills, greater access and openness to new information, greater abilities to assimilate new ideas, experiment, innovate. College graduates are also likely to lead the development, adoption, and diffusion of new technologies (Barro, 2001; Baum, 1996; Geske and Cohn, 1998; Thurow, 1970; Weisbrod, 1968; Wolfe, 1995). In this way, such increases in the overall productivity of a state's workforce produce an unambiguous public benefit by adding to everyone's income rather than only to the incomes of those investing in higher education (Baumol, et al., 1989; Paulsen, 1996a, 1996b, 2001b; Wolfe, 1995).

[7] Baum, 1996; Cohn and Geske, 1990; Paulsen, 2001b.

[8] Breneman, 1981; Halstead, 1974; Lee, 2003; Paulsen, 2001b; Stampen, 1980.

[9] This efficiency-based principle is sometimes referred to as the benefits-received principle and guides us in answering the question of who should pay for educational investments. However, there are also equity-based principles that are highly relevant to this inquiry. One of the most important is called the ability-to-pay principle, which asserts that the distribution of costs and benefits of educational investments should be based on one's ability to pay. In combination, efficiency- and equity-based criteria are used to ensure that the burden of educational costs is distributed to whom the benefits actually accrue (the individual or society) and, among individual students and other members of society, in accordance with differences in income levels. For an example, see Breneman's (1981) use of both principles in his analysis of how the diverse services of community colleges should be financed.

[10] Halstead, 1974; Stampen, 1980.

[11] Breneman and Finney, 1997; Roherty, 1997; Zumeta, 2003.

[12] State appropriations to higher education are a reasonable indicator of society's confidence in the public benefits of higher education for several reasons. First, historically, states have provided the majority of society's investment in higher education. Second, the great majority of the state's investment in higher education is in the form of appropriations to cover a portion of institutions' operating expenses sufficient to permit them to cover the costs of educating their students without having to raise tuition beyond a level that promotes access. Third, about 80 percent of our nation's undergraduate students enroll in state-supported public institutions. See Mortensen, 2003, 7.

[13] U.S. Department of Education, National Center for Education Statistics, Table 330, 372, 2002.

[14] *Ibid.*

[15] Mortensen reports a similar decrease in states' public investments in higher education in terms of the trend in "state investment effort"—measured as state appropriations per $1,000 of personal income in the state. It reached its peak at $10.56 per $1,000 of personal income in FY 1978, but has decreased by 30.4 percent to only $7.35 of state appropriations per $1,000 of personal income in FY 2003. See Mortensen, 2003, 7–8.

[16] U.S. Department of Education, National Center for Education Statistics, Table 330, p. 372, 2002.

[17] Toutkoushian (2001, Table 5, 27) presents a similar pattern of changes by calculating the shares of the costs of educating a student paid by public institutions that are accounted for by net tuition revenues paid per student. He found that the shares of educational costs paid by students and society in 197475 were 13 percent and 87 percent, respectively. By 1994-95, the shares paid by students and society were 19.3

percent and 81 percent, respectively. This provides another kind of illustration of the trend in Americans' beliefs about the relative mix of private and public benefits of higher education, with students' share growing and society's share diminishing over a 20 year period.

[18] Another perspective on the same apparent trend in society's weakening beliefs in the public benefits of postsecondary education is readily observable in the shares of total financial aid given to students in the form of loans versus grants. Between 1981–82 and 2001–02, the percent of total aid to students in the form of loans increased from 41 percent to 54 percent, while the percent in the form of grants decreased from 56 percent to only 39 percent (College Board, 2000, 2002b; Gillespie and Carlson, 1983). This is a special indicator of society's apparently weakening beliefs in the public benefits of higher education, because grants reduce college costs while loans only postpone them (Paulsen, 2000). Finally, growth in tuition at both public and private and at both two-year and four-year institutions have required increasing shares of income for all but the wealthiest families (College Board, 2002a), showing a diminishing concern for ability to pay for college access.

[19] Brenneman and Finney, 1997; Palmer, J., 2003; Roherty, 1997; Zumeta, 2003.

[20] Palmer, J., 2003.

[21] More specifically, between fiscal years 2002 and 2003, 13 states reduced appropriations to public institutions, while 15 more increased appropriations by a percentage that was less than the increase in the Consumer Price Index; between fiscal years 2001 and 2003, nine states reduced appropriations, while 17 increased appropriations less than the rate of increase in the Consumer Price Index. See Palmer, J., 2003, for details.

[22] The College Board, 2002a.

[23] These substantial increases in tuition are consistent with research demonstrating a substantial, negative correlation between state appropriations and tuition at public institutions. See Cunningham, et al., 2001; Paulsen, 1991, 2000.

[24] Callan and Finney, 1997; Paulsen and Smart, 2001.

[25] Individual student investors consider only the private benefits relative to costs in their investment decisions. Public benefits due to such investments accrue to society in general and are "external" to the investment decisions of individual students. If left alone, individual students would ignore public benefits and invest in an amount of higher education that would be less than the amount optimal for society—that is, there would be an underinvestment in higher education. See Baum, 1996; Paulsen, 2001a, 2001b; Thurow, 1970.

[26] Cohn and Geske, 1990; Leslie and Brinkman, 1988; McMahon, 1991; McMahon and Wagner, 1982.

[27] Bowen, 1977; Cohn and Geske, 1992; Haveman and Wolfe, 1984; Malveaux, 2003; Pascarella and Terenzini, 1991; Solmon and Fagnano, 1995; Schultz, 1963; Weisbrod, 1968; Wolfe, 1995.

[28] Caffrey and Isaacs, 1971; Creech, et al., 1994; Leslie and Brinkman, 1988.

[29] Barro, 2001; Baumol, et al., 1989; Denison, 1985; OECD, 2003a, 2003b; Paulsen, 1996a, 1996b; Pencavel, 1993..

[30] Baumol, et al., 1989; Bowen, 1977; Lee, 2003; Leslie and Brinkman, 1988; Weisbrod, 1968; Wolfe, 1995.

[31] Paulsen, 1996a, 1996b.

[32] See, for example, Barro, 2001; Barro and Sala-i-Martin, 1995; Baumol, et al., 1989; OECD, 2003a, 2003b.

[33] Paulsen, 1996a, 1996b.

[34] Pencavel, 1993.

[35] Baum, 1996; Baumol, et al., 1989; Paulsen, 1996a, 1996b, 2001b; Wolfe, 1995.

[36] Gross state product is the "value of the goods and services attributable to labor and property located in a state. It is the State counterpart of the nation's gross domestic

product." (U.S. Department of Commerce, 1992, 423).

[37] All variables based on values of gross state or gross domestic product are in real or inflation-adjusted dollars.

[38] As noted below Table 1, averages may not be consistent with figures in the table due to rounding.

[39] Barro, 2001; Barro and Sala-i-Martin, 1995; Baumol, et al., 1989; OECD, 2003a, 2003b; Paulsen, 1996a, 1996b.

[40] Barro and Sala-i-Martin, 1992, 1995; Baumol, et al., 1989; OECD, 2003a, 2003b; Paulsen, 1996a, 1996b.

[41] Barro and Sala-i-Martin, 1992, 1995.

[42] It is important to note that while the average value of ECONACT is .192, its standard deviation is only .018. Therefore, Oregon's value for economic activity (.202) is more than "one half of" a standard deviation above the sample mean, and Utah's value (.183) is more than "one half of" a standard deviation below the sample mean, thereby representing substantial differences in their respective values for ECONACT.

[43] Finally, the remaining hypothesis was concerned with the relation between the initial workforce productivity in 1990 (PROD) and the subsequent growth in state workforce productivity (GROWTH). PROD was expected to be negatively related to GROWTH, in line with convergence theory. However, results indicate that although the coefficient for the effect of PROD had the expected negative sign, it was not statistically significant (p=.1913) in this study. Therefore, the findings of this study do not support the convergence hypothesis as a characteristic of state economies in the 1990s, an outcome that merits further examination.

[44] Paulsen, 1996a, 1996b.

[45] Barro, 2001; Barro and Sala-i-Martin, 1995; Baumol, et al., 1989.

[46] Barro, 2001; G. Becker, 1993; Paulsen, 2001a, 2001b.

[47] The .88 magnitude of this effect compares favorably with the estimate of 1.19 obtained by Paulsen in his comparable study using data for the 1980s (1996a, 1996b). However, in comparison with Paulsen's earlier work, the measure of economic activity used in the present study is far more complex and comprehensive (see Appendix 1). Using 1980s data, Paulsen measured only the effect of whether or not a state was located in a coastal region. His measure might have been adequate in accounting for differences in economic activity in states differentially affected by the recessions in the agricultural and mining industries in the 1980s, but it would be inadequate as a more general approach to controlling for economic activity regardless of the nature of changes in the nation's economy that affected various industries and state economies differently. Furthermore, the use of the more refined, comprehensive, and powerful measure in the present study, enhances the credibility and validity of the findings of this study regarding the effect of investment in higher education on growth in state workforce productivity.

[48] Mortenson, 2003.

[49] Mortenson, 2003; Zumeta, 2003.

[50] Data on real gross state product for the years of 1990 and 1999, and real gross national product originating in each of 10 industrial sectors were from the Bureau of Economic Analysis, 2001a. Data on the number of persons with bachelor's degrees and the number of high school graduates in 1990 for each state were obtained from the U.S Census Bureau, 2001b. Data on the population and size of the labor force for 1990 and 1999 came from the U.S. Census Bureau, 2000. All analyses used SAS-PC for Windows, v. 8.

[51] For example, PROD would control for the net effects of collective investments and other factors influencing the level of state workforce productivity in 1990 such as literacy and high school education, various forms of technical and corporate training, and the many varieties of physical capital and new technologies in various industries.

[52] Some researchers (e.g., Pencavel, 1993) suggest that sometimes there may be a second

equation necessitating the estimation of a two-equation, non-recursive system in studies such as this. This view is based on the idea that investment in higher education could serve as both a cause and a consequence of growth in workforce productivity. However, the estimated coefficients of Equation (1) in the present study would not be subject to such a simultaneous-equation bias. The reason is the cumulative investment in higher education in state i by the year 1990 ($HIGHED_{90i}$) is not a result of the growth in workforce productivity between 1990 and 1999 ($GROWTH_{99/90i}$); instead, it is the result of growth in a state's workforce productivity over many years prior to the initial year of this study.

[53] It is important to note that the variable HIGHED is not and should not be a measure of how many college graduates a state educated in its own institutions. What it should and does measure is the difference between states in the number of college graduates they actually had in their workforces in 1990—the beginning of the period of analysis. This is an appropriate and important assumption, because it is the actual number of college graduates residing in a state as part of its workforce, instead of the number of college graduates educated in that state, that affects the state's subsequent growth in workforce productivity. Research on the determinants of migration behavior of college graduates between states is an interesting and important topic, but it is beyond the scope of this study.

[54] For example, recessions in the manufacturing or agricultural industry during the period of analysis could suppress growth in gross state product and workforce productivity in states with heavy concentrations in these industries, while states with smaller concentrations in these industries would not be adversely affected by such recessions.

[55] This measure is derived from a similar measure used by Barro and Sala-i-Martin, 1992, 1995, in their research on the economic growth of national, regional, and state economies.

[56] For this study, the sources of gross state product in the national and state economies were disaggregated and divided into 10 industrial sectors: agriculture; mining; construction; manufacturing; transportation and public utilities; wholesale trade; retail trade; finance, insurance, and real estate; services; and government enterprises. Barro and Sala-i-Martin, 1992, 1995, used a similar, but not identical, set of industrial sectors in their analyses.

[57] The values of ECONACT are contemporaneous with the values of the dependent variable, growth in workforce productivity, and they both change between 1990 and 1999. However, we follow Barro and Sala-i-Martin in making the assumption that ECONACT is an exogenous independent variable in the model for two reasons. First, the potential impact of changes in economic activity in any one individual state on an aggregate measure of activity in various industries in the national economy is minimal. Second, the weights, W_{ijt}, which do vary across states, are based only on 1990 values and remain constant throughout the period of analysis. See Barro and Sala-i-Martin, 1992, 234 and 1995, 391.

[58] Any migration of college graduates between states that might occur during the period of analysis is addressed by the data and measures used in this study. Migration research has consistently shown that migration of college graduates between states is consistently responsive to and correlated with job market signals associated with expansions and contractions in the sectors of state economies where the labor force typically includes substantial portions of college-educated workers (Barro and Sala-i-Martin, 1995). Therefore, the effects of any such migration occurring during the period of analysis are accounted and controlled for, in large part, by ECONACT, the complex and comprehensive measure of expansions and contractions in 10 distinct industrial sectors in each state's economy between 1990 and 1999.

[59] Estimating regression coefficients with cross-section data sometimes introduces heteroskedasticity. Park-Glejser tests using all independent variables, separately, or in combination, revealed no evidence of heteroskedasticity (Pindyck and Rubinfeld, 1981, 150-151). Also, multicollinearity diagnostics revealed that tolerance values exceeded, and variance inflation factors were well below, criterion levels by a wide margin for all independent variables (Montgomery and Peck, 1992, and Stevens, 1996).

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