MAIN REPORT

Economic Contribution of Washington's Community and Technical Colleges

Analysis of Investment Effectiveness and Economic Growth

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emsi

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Preface

The EMSI impact model left the development stage late in 2000 after undergoing field tests with eight pilot colleges. We have now applied the model to generate more than 900 studies for colleges in the US, Canada, the UK, and Australia. Along the way we have continuously adapted the model in an ongoing effort to ensure that it conforms to best practices and that it stays relevant in today's economy.

With the release of the present version of the model, we introduce a more dramatic set of revisions. Two of the most significant improvements include the "substitution" adjustment, which we apply in our calculation of student productivity effects (see pg. 37); and our attrition module, which examines the movement of workers in and out of the regional workforce (see pgs. 17 and 22). These and other revisions have naturally caused variances in the results between the current model and those of previous versions.

Economic changes also contribute to variances in the results. This is because several important variables in the model are integrally tied to economic indicators such as regional earnings, state and local tax rates, and economic output. All of these fluctuate as economic conditions change or as government puts new policies into practice.

Given the model revisions and economic shifts, differences between this study and those previously conducted by EMSI are normal and even expected. Because of this, we encourage readers to view the results of this study as a snapshot of current conditions, not as a benchmark for making comparisons across years. Such comparisons are difficult to do and often lead to erroneous conclusions about college performance.

As you read through this report, therefore, please keep in mind that the results reflect the latest version of the model and are largely informed by the current state of the economy. Variances between the results and those of past studies are not to be taken as indicative of college performance but rather as a reflection of today's economic conditions and prevailing economic theory.

Introduction

Study overview

Washington's community and technical colleges generate a wide array of benefits. Students benefit from higher personal income, and society benefits from cost savings associated with reduced welfare and unemployment, improved health, and reduced crime. Education, however, requires a substantial investment on the part of students and taxpayers. All of the education stakeholders, therefore, want to know if they are getting their money's worth. In this study, Washington's community and technical colleges investigate the attractiveness of their returns as public training providers relative to alternative public investments. The following two analyses are presented: 1) investment analysis, and 2) economic growth analysis.

Investment analysis

The investment analysis captures private and public benefits that accrue to students and taxpayers in return for their educational support. Private benefits include higher income of students, while public benefits include growth in income plus an assortment of positive externalities such as improved health and lifestyle habits, reduced crime, and fewer claims for social assistance. All of these annual benefits continue and accrue into the future for as long as students are in the workforce. To determine the feasibility of the investment, the model projects benefits into the future, discounts them back to the present, and compares them to present costs. Results are displayed in the four following ways: 1) net present value, 2) rate of return, 3) benefit/cost ratio, and 4) payback period.

Economic growth analysis

The economic growth analysis focuses on the role Washington's community and technical colleges play in promoting economic development by increasing consumer spending and raising the skill level of the labor force. This in turn leads to more jobs, increased business efficiency, greater availability of public investment funds, and eased tax burdens. Results are expressed in terms of income, which comprises both labor income (*i.e.*, wages, salaries, and proprietors' income) and non-labor income (*i.e.*, dividends, interests, and rents). In general, college-linked income falls under the following three categories: 1) income generated by the annual operating expenditures of Washington's community and technical colleges, 2) income generated by the spending of out-of-state students; and, 3) income generated by college skills embodied in the workforce.

Note of importance

Although the reports generated for Washington's community and technical colleges are similar to those prepared for other statewide systems, the results differ widely. **These differences, however, do not necessarily indicate that some systems are doing a better job than others.** Results are a reflection of location, student body profile, and other factors that have little or nothing to do with the relative efficiency of the systems. For this reason, comparing results between state systems or using the data to rank systems is strongly discouraged.

Organization of the report

This report has four chapters and seven appendices. Chapter 1 provides an overview of Washington's community and technical colleges and the state economy. Chapter 2 presents the investment analysis results from the students' and taxpayers' perspectives. Chapter 3 considers the impact of the colleges on economic growth in Washington. Finally, Chapter 4 provides sensitivity analyses of some of the key variables.

The appendices include a list of resources and references in Appendix 1, a glossary of terms in Appendix 2, a discussion of the EMSI input-output model in Appendix 3, a detailed explanation of the shutdown point (an adjustment factor) in Appendix 4, an overview of the data and assumptions used in calculating the non-economic (*i.e.*, social) benefits of education in Appendix 5, a short primer on the investment analysis results in Appendix 6, and an explanation of the alternative education variable in Appendix 7.

Chapter 1: Profile of Colleges and the State Economy

Introduction

Estimating the benefits and costs of Washington's community and technical colleges requires the following three types of information: (1) college and student body profiles, (2) the economic profile of the state, and (3) statistics relating education to improved social behavior. For the purposes of this study, information on the college and student body profiles was obtained from the Washington State Board for Community and Technical Colleges (SBCTC); data on the state economy were drawn from public databases; and statistics on social behavior were provided by national studies and surveys.

Community and technical college system profile

Revenues

Table 1.1 shows the annual revenues of Washington's community and technical colleges by funding source—a total of $2.4 billion in FY 2009-10. These data are critical in identifying annual costs of educating the student body from the perspectives of students and taxpayers alike. As indicated, tuition and fees comprised 20.7% of total revenue, revenue from state government 45.4%, federal government revenue 15.9%, and all other revenue (*i.e.*, auxiliary revenue, sales and services, interest, and donations) the remaining 18.0%.

Table 1.1: Revenue of Washington's community and technical colleges by source, FY 2009-10 ($ thousands)

Source	Total	%
Tuition and fees	$488,236	20.7%
State government revenue	$1,069,808	45.4%
Federal government revenue	$373,644	15.9%
All other revenue	$423,210	18.0%
Total revenues	**$2,354,899**	**100.0%**

* Numbers may not add due to rounding.

Source: Data supplied by SBCTC.

Expenditures

Washington's community and technical colleges employed 15,978 FTE faculty and staff in the 2009-10 reporting year. The combined payroll at the colleges amounted to $1.1 billion. Other expenditures, including capital and purchases of supplies and services, made up $1.2 billion. These budget data appear in Table 1.2.

Table 1.2: Expenses of Washington's community and technical colleges by function, FY 2009-10 ($ thousands)

Source	Total	%
Salaries, wages, and benefits	$1,071,467	46.8%
Capital expenditures and depreciation	$278,730	12.2%
All other non-pay expenditures	$941,375	41.1%
Total expenses	**$2,291,571**	**100.0%**

* Numbers may not add due to rounding.

Source: Data supplied by SBCTC.

Student profile

Demographics

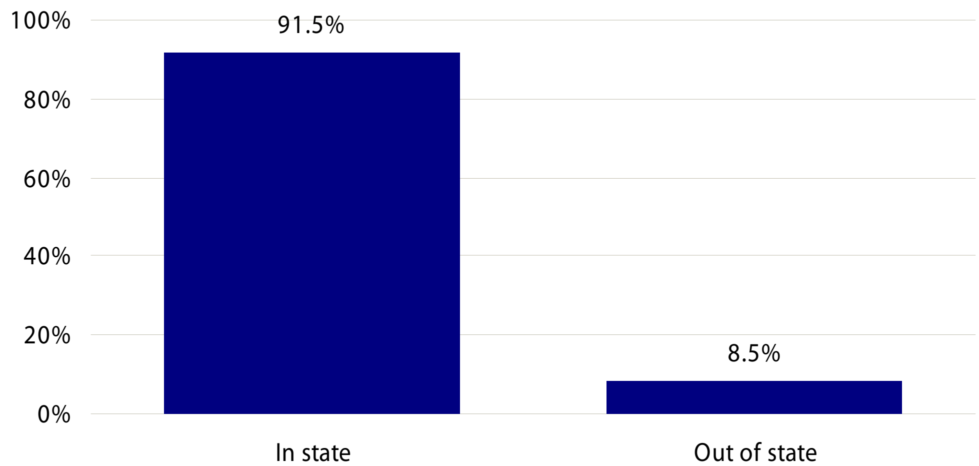
Washington's community and technical colleges served 469,907 students in the 2009-10 reporting year (unduplicated).[1] The breakdown of the student body by gender was 43.2% male and 56.8% female, while the breakdown by ethnicity was 64.5% whites and 35.5% students of color. The students' median age was 31.[2]

Figure 1.1 presents the settlement patterns of students attending Washington's community and technical colleges. As indicated, 91.5% of students remain in the state, and the remaining 8.5% settle outside the state.

[1] Includes all funding sources, *i.e.*, state-funded, contract-funded, and student-funded.

[2] Based on the number of students who reported their age, gender, and ethnicity.

Figure 1.1: Student settlement patterns



Degrees, certificates, and credit production

Table 1.3A summarizes the breakdown of degrees and certificates awarded to students. As indicated, Washington's community and technical colleges served 47 bachelor's degree graduates, 18,317 associate's degree graduates, and 3,160 long certificate graduates in the 2009-10 reporting year. Table 1.3B shows the areas of study for students continuing their education in 2009-10. The colleges served 102,145 transfer students, 17,152 dual enrollment students (*i.e.*, Running Start, College in the High School, and Tech Prep programs), 48,716 basic skills students, and 81,353 personal enrichment students. The majority of personal enrichment courses are self-support classes, meaning no state funding is used to provide these courses. They are funded solely by student tuition/fees or other non-state funds. In the analysis, we exclude the credit production of personal enrichment students under the assumption that they do not attain workforce skills that will increase their earnings. Workforce and all other students comprised the remaining 199,016 students.

Also shown in Tables 1.3A and 1.3B is the credit production of each student group. In the model, we use credits or credit hour equivalents (CHEs) as a measurement of student achievement. Altogether, students at Washington's community and technical colleges completed 6,199,774 credit hour equivalents (or CHEs) during the 2009-10 reporting year. The average number of CHEs per student (excluding personal enrichment students) was 15.4. In Chapter 2 of this report, we describe in greater detail how we attach a dollar value to the students' CHE production and how this in turn translates to quantifiable benefits to both students and the economy as a whole.

Table 1.3A: Degrees and certificates, 2009-10

Category	Headcount	Total CHEs	Avg. CHEs
Bachelor's degree graduates	47	1,379	29.3
Associate's degree graduates	18,317	611,781	33.4
Long certificate graduates	3,160	126,952	40.2

Table 1.3B: Continuing students - credit production by area of study

Category	Headcount	Total CHEs	Avg. CHEs
Transfer students	102,145	1,974,762	19.3
Dual enrollment students	17,152	460,663	26.9
Basic skills students	48,716	194,078	4.0
Personal enrichment students	81,353	231,629	2.8
Workforce and all other students	199,016	2,598,531	13.1
Total/average (all students)*	**469,907**	**6,199,774**	**15.4**

* The overall average number of CHEs per student excludes personal enrichment students.

Source: Data supplied by SBCTC.

Economic profile of state

Since Washington's community and technical colleges first opened their doors to students, they have been serving the state's communities by supporting job growth and creating income, providing state residents with easy access to higher education opportunities, and preparing students for highly-skilled, technical professions. The availability of quality education and training in Washington also attracts new industry to the state, thereby generating new businesses and expanding the availability of public investment funds.

Table 1.4 summarizes the breakdown of the Washington economy by major industrial sector, with details on labor and non-labor income. Labor income refers to wages, salaries, and proprietors' income; while non-labor income refers to profits, rents, and other income. Together, labor and non-labor income comprise a state's total gross state product, or GSP.[3]

As shown in Table 1.4, Washington's GSP is approximately $291.9 billion, equal to the sum of labor income ($201.7 billion) and non-labor income ($90.2 billion). In

[3] See the glossary of terms in Appendix 2 for a full definition of GSP.

Chapter 3, we use Washington's gross state product as the backdrop against which we measure the relative impacts of the colleges on economic growth in the state.

Table 1.4: Labor and non-labor income by major industrial sector in Washington, 2010 ($ millions)*

Industry Sector	Labor income	Non-labor income	Total income	% of total
Agriculture, forestry, fishing and hunting	$4,108	$2,133	$6,242	2%
Mining	$375	$459	$834	<1%
Utilities	$518	$1,241	$1,759	<1%
Construction	$12,121	$1,417	$13,538	5%
Manufacturing	$21,306	$11,777	$33,083	11%
Wholesale trade	$9,623	$6,969	$16,593	6%
Retail trade	$12,390	$7,006	$19,395	7%
Transportation and warehousing	$6,999	$2,372	$9,371	3%
Information	$13,333	$12,157	$25,490	9%
Finance and insurance	$11,489	$9,642	$21,131	7%
Real estate and rental and leasing	$4,725	$15,759	$20,484	7%
Professional and technical services	$18,064	$3,100	$21,164	7%
Management of companies and enterprises	$3,484	$635	$4,119	1%
Administrative and waste services	$7,048	$1,922	$8,969	3%
Educational services	$2,339	$289	$2,628	<1%
Health care and social assistance	$19,858	$1,771	$21,630	7%
Arts, entertainment, and recreation	$2,034	$729	$2,764	<1%
Accommodation and food services	$4,683	$2,508	$7,191	2%
Other services, except public administration	$5,595	$793	$6,389	2%
Federal government	$13,983	$4,986	$18,969	6%
State and local government	$27,591	$2,568	$30,159	10%
Total	**$201,667**	**$90,233**	**$291,901**	**100%**

* Data reflect the most recent year for which data are available. EMSI data are updated quarterly.

† Numbers may not add due to rounding.

Source: EMSI.

Conclusion

This chapter presents the broader elements of the database used to determine the results. Additional detail on data sources, assumptions, and general methods underlying the analyses are conveyed in the remaining chapters and appendices. The core of the findings is presented in the next two chapters—Chapter 2 looks at Washington's community and technical colleges as an investment, while Chapter 3 considers the role of the colleges in economic growth. The appendices detail a collection of miscellaneous theory and data issues.

Chapter 2: Investment Analysis

Introduction

Investment analysis is the process of evaluating total costs and measuring these against total benefits to determine whether or not a proposed venture will be profitable. If benefits outweigh costs, then the investment is worthwhile. If costs outweigh benefits, then the investment will lose money and is thus considered infeasible.

In this chapter, we consider Washington's community and technical colleges as an investment from the perspectives of students and taxpayers, the major stakeholders. The backdrop for the analysis is the entire state of Washington.

Student perspective

Analyzing the benefits and costs of education from the perspective of students is the most obvious—they give up time and money to go to college in return for a lifetime of higher income. The benefit component of the analysis thus focuses on the extent to which student incomes increase as a result of their education, while costs comprise the monies they put up.

Linking education to earnings

The correlation between education and earnings is well documented and forms the basis for determining the benefits of education. As shown in Table 2.1, mean income levels at the midpoint of the average-aged worker's career increase for individuals who have attained higher levels of education. These numbers are derived from EMSI's industry data on average income per worker in Washington,[4] broken out by gender, ethnicity, and education level using data supplied by the U.S. Census Bureau.

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[4] It is important to note that wage rates in the EMSI model combine state and federal sources to provide earnings that reflect proprietors, self-employed workers, and others not typically included in state data, as well as benefits and all forms of employer contributions. As such, EMSI industry earnings-per-worker numbers are generally higher than those reported by other sources.

Figure 2.1: Average annual income at career midpoint

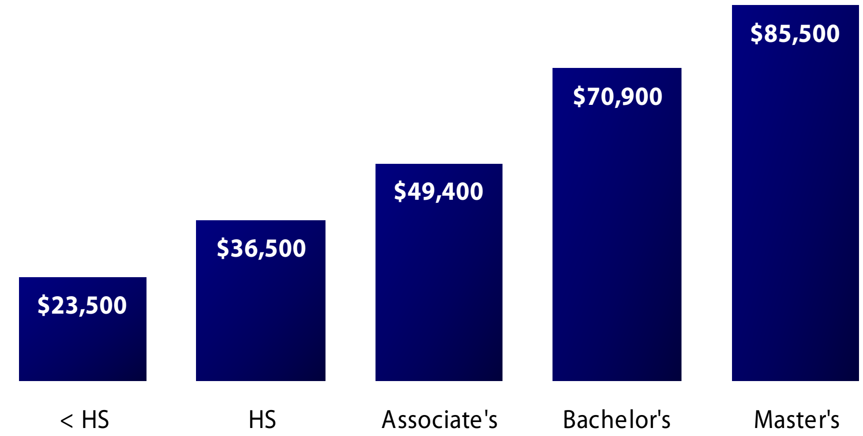

Table 2.1: Expected annual income in Washington at midpoint of individual's working career by education level

Education level	Income	Difference
Less than high school	$23,500	n/a
High school or equivalent	$36,500	$13,000
Associate's degree	$49,400	$12,900
Bachelor's degree	$70,900	$21,500
Master's degree	$85,500	$14,600

Source: Derived from data supplied by EMSI industry data and the U.S. Census Bureau. Figures are adjusted to reflect average earnings per worker in Washington.

The differences between income levels define the marginal value of moving from one education level to the next. For example, students who move from a high school diploma to an associate's degree may expect approximately $12,900 in higher annual income. The difference between a high school diploma and the attainment of a bachelor's degree is even greater – up to $34,400 in higher income.

Of course, several other factors such as ability, socioeconomic status, and family background also positively correlate with higher earnings. Failure to account for these factors results in what is known as an "ability bias." A literature review by Chris Molitor and Duane Leigh indicates that the upper limit benefits defined by correlation should be discounted by 10%.[5] As such, we adjust the gross increase in income downward by 10%.

[5] Chris Molitor and Duane Leigh, "Estimating the Returns to Schooling: Calculating the Difference Between Correlation and Causation" (Pullman, WA: March 2001). Report available upon request.

Determining the value per CHE

Not all students who attended Washington's community and technical colleges in the 2009-10 reporting year obtained a degree or certificate in the course of the year. Some may have returned the following year to complete their education goals, while others may have taken a few courses and entered the workforce without achieving a credential. As such, the only way to measure the value of the students' achievement is through their credit hour equivalents, or CHEs. This allows us to see the benefits to all students, not just to those who earn an award.

In the model, we calculate the value of the students' CHE production through a complex process that involves dividing the education ladder into a series of individual steps, each equal to one credit. We then spread the income differentials from Table 2.1 over the steps required to complete each education level, assigning a unique value to every step in the ladder.[6] Next, we apply a continuous probability distribution to map the students' CHE production to the ladder, depending on their level of achievement and the average number of CHEs they achieve. Finally, we sum the number of CHEs earned at each step and multiply them by their corresponding value to arrive at the students' average annual increase in income.

Table 2.2 displays the aggregate annual higher income for the student population at Washington's community and technical colleges. Also shown are the total CHEs generated by students and the average value per CHE. Note that, although each step in the education ladder has a unique value, for the sake of simplicity, only the total and average values are displayed.

Table 2.2: Aggregate higher income at students' career midpoint and average value per CHE

	Total/Avg
Higher annual income, aggregate (thousands)	$694,384
Total non-leisure credit hour equivalents (CHEs)	5,968,145
Average value per CHE	$116

* Numbers may not add due to rounding.

Source: EMSI impact model.

Here a qualification must be made. Research shows that earnings levels do not remain constant; rather, they start relatively low and gradually increase as the worker

[6] Students who obtain a certificate or degree during the reporting year are granted a "ceremonial boost" in the calculations in recognition of the fact that an award has greater value than the individual steps required to achieve it.

gains more experience. Research also indicates that the earnings increment between educated and non-educated workers grows through time. This means that the aggregate annual higher income presented in Table 2.2 will actually be lower at the start of the students' career and higher near the end of it, gradually increasing at differing rates as the students grow older and advance further in their careers. To model this change in earnings, we use the well-known and well-tested Mincer function, which we discuss more fully in the next section.

Generating a benefits stream

The two names most often associated with human capital theory and its applications are Gary Becker and Jacob Mincer.[7] The standard human capital earnings function developed by Mincer appears as a three-dimensional surface with the key elements being earnings, years of education, and experience. Figure 2.2 shows the relationship between earnings and age, with age serving as a proxy for experience. Note that, since we are using the graph strictly for illustrative purposes, the numbers on the axes are not shown.

Figure 2.2: Earnings for 12 vs. 14 years of education

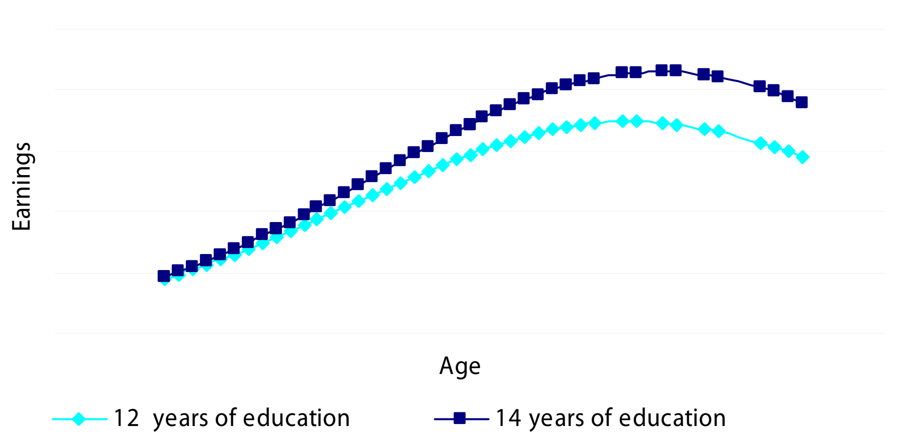

Figure 2.2 illustrates several important features of the Mincer function. First, earnings initially increase at an increasing rate, later increase at a decreasing rate, reach a maximum somewhere after the midpoint of the working career, and then decline in later years. Second, at higher levels of education, the maximum level of earnings is reached at an older age. And third, the benefits of education, as measured by the difference in earnings for two levels, increase with age.

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[7] See Gary S. Becker, *Human Capital: a Theoretical Analysis with Specific Reference to Education* (New York: Columbia College Press for NBER, 1964); Jacob Mincer, "Schooling, Experience and Earnings" (New York: National Bureau of Economic Research, 1974); and Mincer, "Investment in Human Capital and Personal Income Distribution," *Journal of Political Economy,* vol. 66 issue 4, August 1958: 281–302.

In the model, we employ the Mincer function as a smooth predictor of earnings over time,[8] for as long as students remain active in the workforce. Using earnings at the career midpoint as our base (Table 2.1), we derive a set of scalars from the slope of the Mincer curve to model the students' increase in earnings at each age within their working careers. The result is a stream of projected future benefits that follows the same basic shape as the Mincer curve, where earnings gradually increase from the time students enter the workforce, come to a peak shortly after the career midpoint, and then dampen slightly as students approach age 65 (when people generally start working fewer hours or retire).

The benefits stream generated by the Mincer curve is a key component in deriving the students' rate of return. However, not all students enter the workforce at the end of the reporting year, nor do all of them remain in the workforce until age 65. To account for this, we discount the students' benefit stream in the first few years of the time horizon to allow time for those who are still studying at the colleges to complete their educational goals and find employment. Next, we discount the entire stream of benefits by the estimated number of students who will die, retire, or become unemployed over the course of their working careers.[9] The likelihood that students will leave the workforce increases as they age, so the older the student population is, the greater the attrition rate applied by the model will be.

Having calculated the students' benefits stream and adjusted for attrition, we next turn to student costs. These are discussed more fully in the next section.

Calculating student costs

Student costs comprise tuition and fees, books and supplies, and the opportunity cost of time. Tuition and fees amount to $488.2 million (see Table 1.1). Full-time students also spend an average of $1,036 per year on books, supplies, and equipment.[10] Multiplying this figure by the number of full-time equivalents (FTEs) achieved by the student population yields approximately $112.4 million spent on books and supplies in the 2009-10 reporting year.

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[8] The Mincer equation is computed based on estimated coefficients presented in Robert J. Willis, "Wage Determinants: A Survey and Reinterpretation of Human Capital Earnings Function" in *Handbook of Labor Economics*, Vol. 1 (Amsterdam: Elsevier Science Publishers, 1986): 525–602. These are adjusted to current year dollars in the usual fashion by applying the GDP implicit price deflator. The function does not factor in temporary economic volatility, such as high growth periods or recessions. In the long run, however, the Mincer function is a reasonable predictor.

[9] These data are provided by a variety of sources, including the Center for Disease Control and Prevention (CDC), the Social Security Administration (SSA), and the Bureau of Labor Statistics (BLS).

[10] Based on the College Board's Annual Survey of Colleges, 2008.

Opportunity cost is the most difficult component of student costs to calculate. It refers to the value of time and earnings forgone by students who choose to attend college rather than work full-time. We derive opportunity costs by establishing the full earning potential of students at the median age (31) and education level of the student population, and then comparing this to what they are actually earning while attending college.

We begin with the average annual incomes by education level from Table 2.1 and weight these according to the students' education level at the start of the reporting year.[11] However, recall that Table 2.1 displays earnings at the midpoint of the individual's working career, not immediately upon exiting college. To arrive at the full earning potential of students while enrolled, we must condition the earnings levels to the students' age, which we accomplish simply by applying a scalar derived from the Mincer curve described above.

Another important factor to consider is the time that students actually spend at college, as this is the only part of the year that they would potentially be required to give up earnings as a result of their education. We use the students' CHE production as a proxy for time, under the assumption that the more CHEs students earn, the less time they have to work, and, consequently, the more earnings they potentially have to give up.

Note that the opportunity cost calculations only apply to students who are economically active, *i.e.*, those who work or are seeking work. An estimated 44% of the student population is employed while attending.[12] For those who are not working, we assume that they are either seeking work or will seek work once they complete their educational goals (with the exception of personal enrichment students, who are not being considered in this calculation).

The differentiation between working and non-working students is important because they are treated differently in the model. Non-working students are assumed to give up their entire earning potential while enrolled. Working students, on the other hand, are able to maintain all or part of their income, so their opportunity cost is not as high. However, many of them give up a significant portion of their leisure time,[13] while others hold jobs that pay less than statistical averages (usually because they can only find work that fits their course schedule). To account for both of these factors,

[11] Based on the number of students who reported their entry level of education.

[12] Based on the number of students who reported their employment status.

[13] See James M. Henderson and Richard E. Quandt, *Microeconomic Theory: A Mathematical Approach* (New York: McGraw-Hill Book Company, 1971).

we assume that working students give up 53% of their full earning potential while attending college, depending on their age and education level.[14]

Total opportunity cost for working and non-working students appears in Table 2.3. Also shown are the cost of tuition and fees and the cost of books and supplies, less monies paid by personal enrichment students. Finally, we net out grants and scholarships refunded to students, as these represent a gain and not a cost to students. Total student costs thus come to $2.3 billion, as shown in the bottom row of Table 2.3.

Table 2.3: Student costs, 2009-10 ($ thousands)

	Total
Education cost	
Tuition and fees	$488,236
Books and supplies	$112,395
Opportunity cost	
Working students	$571,283
Non-working students	$1,313,571
Adjustments	
Less monies paid by leisure students	-$20,997
Less grants and scholarships refunded to students	-$128,906
Total student costs	**$2,335,582**

* Numbers may not add due to rounding.

Source: Based on data supplied by SBCTC and outputs of the EMSI impact model.

Return on investment

Having calculated the students' future benefits stream and the associated costs, the next step is to discount the results to the present to reflect the so-called time value of money. For the student perspective we assume a discount rate of 4% (see the "Discount Rate" box). Present values of benefits are then collapsed down to one number and compared to student costs to derive the investment analysis results, expressed in terms of benefit/cost ratios, rates of return, and payback periods. The

[14] This assumption is based on the following: (1) the value of leisure time, assumed to have a value equal to 20% of students' full earning potential, and (2) the percent of earnings forgone by students who work at jobs that pay less than statistical averages while enrolled. This latter assumption, equal to 33%, is derived from data supplied by approximately 200 institutions previously analyzed by EMSI. For more information on the value of leisure time, see Becker, 1964.

investment is feasible if returns match or exceed the minimum threshold values, *i.e.*, a benefit/cost ratio greater than 1, a rate of return that exceeds the discount rate, and a reasonably low payback period.

Discount Rate

The discount rate is a rate of interest that converts future costs and benefits to present values. For example, $1,000 in higher earnings realized 30 years in the future is worth much less than $1,000 in the present. All future values must therefore be expressed in present value terms in order to compare them with investments (i.e., costs) made today. The selection of an appropriate discount rate, however, can become an arbitrary and controversial undertaking. As suggested in economic theory, the discount rate should reflect the investor's opportunity cost of capital, i.e., the rate of return one could reasonably expect to obtain from alternative investment schemes. In this study we assume a 4% discount rate from the student perspective and a 3% discount rate from the taxpayer perspective. The discount rate from the taxpayer perspective is lower because governments are large and can therefore spread their risks over a larger and more diverse investment portfolio than the private sector can.

As shown in Table 2.4, higher student income is projected across the working life of students, discounted to the present, and added together to yield a cumulative sum of $13.7 billion, the present value of all of the future income increments. This may also be interpreted as the gross capital asset value of the students' higher income stream. Accordingly, the aggregate 2009-10 student body is rewarded with a capital asset valued at $13.7 billion as a result of their attendance at Washington's community and technical colleges.

Table 2.4: Present value of benefits and costs, student perspective ($ thousands)

	Total
Present value of future benefit stream	$13,685,411
Present value of costs	$2,335,582
Net present value	$11,349,829
Benefit/cost ratio	5.9
Internal rate of return	20.8%
Payback period (no. of years)	7.1

* Numbers may not add due to rounding.

Source: EMSI impact model.

Next, we compare the benefits to the associated costs to judge whether attending college is a good investment. Costs are provided in the second row of Table 2.4, equal to $2.3 billion. Note that costs only occur in the single reporting year and are thus already in current year dollars, so their present value equals what is reported in Table 2.3. Comparing costs with the present value of benefits yields a student benefit/cost ratio of 5.9 (equal to $13.7 billion in benefits divided by $2.3 billion in costs).

The rate of return is perhaps the most recognized indicator of investment effectiveness. Given the cost of education and the stream of associated future benefits, the rate of return indicates how much a bank would have to pay a depositor of like amount to yield an equally rewarding stream of future payments.[15] Table 2.4 shows students at Washington's community and technical colleges earning average returns of 20.8% on their investment of time and money. This is indeed an impressive return compared, for example, to 1% on a standard bank savings account, or approximately 7% on stocks and bonds (thirty-year average return).

The payback period is defined as the length of time it takes to entirely recoup the initial investment.[16] Beyond that point, returns are what economists would call "pure costless rent." As indicated in Table 2.4, students at Washington's community and technical colleges see, on average, a payback period of 7.1 years on their forgone earnings and out-of-pocket costs.

Social perspective

Any benefits that impact the state as a whole—whether students, employers, taxpayers, or whoever else stands to benefit from the activities of Washington's community and technical colleges—are counted as benefits under the social perspective. We subdivide these benefits into the following two main components: (1) increased income in the state, and (2) social externalities stemming from the improved lifestyles of students, such as better health, reduced crime, and fewer incidences of unemployment (see the "Beekeeper Analogy" box).

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[15] Rates of return are computed using the familiar "internal rate of return" calculation. Note that, with a bank deposit or stock market investment, the depositor puts up a principal, receives in return a stream of periodic payments, and then recovers the principal at the end. An education investor, on the other hand, receives a stream of periodic payments that include the recovery of the principal as part of the periodic payments, but there is no principal recovery at the end. These differences notwithstanding, comparable cash flows for both bank and education investors yield the same internal rate of return.

[16] Payback analysis is generally used by the business community to rank alternative investments when safety of investments is an issue. Its greatest drawback is that it takes no account of the time value of money.

Beekeeper Analogy

A classic example of positive externalities (sometimes called "neighborhood effects") in economics is the private beekeeper. The beekeeper's intention is to make money by selling honey. Like any other business, the beekeeper's receipts must at least cover his operating costs. If they don't, his business will shut down.

But from society's standpoint, there is more. Flower blossoms provide the raw input bees need for honey production, and smart beekeepers locate near flowering sources such as orchards. Nearby orchard owners, in turn, benefit as the bees spread the pollen necessary for orchard growth and fruit production. This is an uncompensated external benefit of beekeeping, and economists have long recognized that society might actually do well to subsidize positive externalities such as beekeeping.

Educational institutions are in some ways like beekeepers. Strictly speaking, their business is in providing education and raising people's incomes. Along the way, however, external benefits are created. Students' health and lifestyles are improved, and society indirectly enjoys these benefits just as orchard owners indirectly enjoy benefits generated by beekeepers. Aiming at an optimal expenditure of public funds, the impact model tracks and accounts for many of these external benefits and compares them to public costs (what taxpayers agree to pay) of education.

Increased income

Income growth occurs as the higher earnings and added skills of students from Washington's community and technical colleges stimulate the production of income in the state. Students earn more because of the skills they learned while attending college, and businesses earn more because student skills make capital more productive (*i.e.*, buildings, machinery and everything else). This in turn raises profits and other business property income. Together, increases in labor and capital income are considered the effect of a skilled workforce.

Estimating the effect of Washington's community and technical colleges on income growth in the state begins with the projected higher student income from Table 2.4. Not all of these benefits may be counted as benefits to the public, however. Some students leave the state during the course of their careers, and any benefits they generate leave the state with them. To account for this dynamic, we combine student origin data from SBCTC with data on migration patterns from the U.S. Census Bureau to estimate the number of students who leave the state workforce over time.

Once we have adjusted for state attrition, we derive a stream of earnings benefits that accrue to the public. These comprise the direct effect of Washington's community and technical colleges on state income growth. Indirect effects occur when students spend more money on consumer goods, while the increased output of businesses that employ them also creates a demand for inputs and, consequently, input spending.

The effect of these two spending items (consumer and business spending) leads to still more spending and more income creation, and so on. To quantify the impact of these several rounds of spending, we apply a multiplier[17] derived from EMSI's specialized input-output (IO) model, described more fully in Appendix 3.

With an increase in labor income (both direct and indirect) comes an increase in capital investment,[18] thereby generating even more growth in the non-labor (or "non-earnings") share of the economy. Non-labor income consists of monies gained through investments, including dividends, interests, and rent. To derive the growth in non-labor income, we multiply the direct and indirect labor income figures by a ratio of Washington's gross state product (equal to labor income plus non-labor income) to total labor income in the state.

Table 2.5 summarizes the average annual increase in state income due to the higher earnings of the 2009-10 student population at Washington's community and technical colleges. Note that, for the sake of consistency with the annual student benefits discussed earlier in this chapter, the table only shows the aggregate increase in state income at the midpoint of the students' careers. As before, these figures must be projected out into the future and discounted to the present before weighing them against the costs. Before doing so, however, we must first turn to the social externalities, as these comprise another key component of the benefits that accrue to the public.

Table 2.5: Aggregate added state income at students' career midpoint ($ thousands)

	Total
Labor income	$721,976
Non-labor income	$427,184
Total added state income	**$1,149,160**

* Numbers may not add due to rounding.

Source: EMSI impact model.

17 Multipliers are common to economic impact analysis and are used to measure how money cycles through the economy.

18 In the production process, skilled labor and capital complement each other (*i.e.*, they have a relatively low elasticity of substitution). Accordingly, an increase in skilled labor increases the productivity and income of existing capital while encouraging additional capital investment.

Social externalities

In addition to higher income, education is statistically correlated with a variety of lifestyle changes that generate social savings, also known as external or incidental benefits of education. These social savings represent avoided costs that would have otherwise been drawn from private and public resources absent the education provided by Washington's community and technical colleges.

It is important to note that calculating social externalities is not a straightforward task of counting actual monies saved. The process is difficult because of the uncertainties about what data to include, what methodologies to employ, and what assumptions to make. Because of this, results should not be viewed as exact, but rather as indicative of the impacts of education on health and well-being.

Data relating education to improved social behavior are available from a variety of sources, including the U.S. Census Bureau, the U.S. Department of Labor, and national studies and surveys analyzing the impacts of substance abuse, crime, and unemployment on society. Data on social costs are also relatively abundant. By combining these data sets, we are able to quantify how education contributes to the lowering of social costs and, ultimately, improves quality of life.

Social benefits break down into three main categories: 1) health savings, 2) crime savings, and 3) welfare and unemployment savings. Health savings include avoided medical costs associated with tobacco and alcohol abuse. Crime savings consist of avoided police, incarceration, prosecution, and victim costs, as well as benefits stemming from the added productivity of individuals who would have otherwise been incarcerated. Welfare and unemployment benefits comprise avoided costs due to the reduced number of social assistance and unemployment insurance claims.

In the model, we quantify the effect of social externalities first by calculating the probability at each education level that individuals will have poor health, commit crimes, or claim welfare and unemployment benefits. Deriving the probabilities involves assembling data at the national level, breaking them out by gender and ethnicity and adjusting them from national to state levels. We then spread the probabilities across the education ladder and multiply the marginal differences by the corresponding CHE production at each step. The sum of these effects counts as the upper bound measure of the number of individuals who, due to the education they received at Washington's community and technical colleges, will not have poor health, commit crimes, or claim welfare and unemployment benefits.

Of course, there are other influences that impact an individual's behavior, and separating these out from the non-economic benefits of education is a challenging task. For the purpose of this analysis, we dampen the results by the "ability bias" adjustment discussed earlier in this chapter to account for other influences besides education that correlate with an individual's quality of life, such as socioeconomic status and family background.

The final step is to express the results in dollar terms by multiplying them by the associated costs per individual, based on data supplied by national studies and surveys.[19] These comprise the overall savings to society. Results of the analysis are displayed in Table 2.6. As before (and again for the sake of consistency), only the estimated savings that occur at the students' career midpoint are shown.

Table 2.6: Aggregate avoided social costs at students' career midpoint ($ thousands)

		Total
Health		
Smoking-related savings		$14,610
Alcohol-related savings		$28,048
	Total health savings	$42,658
Crime		
Incarceration savings		$1,369
Crime victim savings		$1,211
Added productivity		$1,857
	Total crime savings	$4,437
Welfare/unemployment		
Welfare savings		$2,660
Unemployment savings		$933
	Total unemployment savings	$3,593
Total avoided social costs		**$50,688**

* Numbers may not add due to rounding.

Source: EMSI impact model.

Smoking- and alcohol-related savings amount to $42.7 million, including avoided social costs due to a reduced demand for medical treatment and social services, improved worker productivity and reduced absenteeism, and a reduced number of vehicle crashes and alcohol or smoking-induced fires. Since the probability that

[19] For more information on the data and assumptions used in estimating the social externalities, please see Appendix 5 and the resources and references list in Appendix 1.

individuals will manifest poor health habits is greater than the probability that they will be incarcerated or become unemployed, the savings associated with health are also considerably greater.

Crime savings sum to $4.4 million. These reflect avoided social costs associated with a reduced number of crime victims, added worker productivity, and reduced expenditures for police and law enforcement, courts and administration of justice, and corrective services. Finally, welfare and unemployment savings amount to $3.6 million, stemming from a reduced number of persons in need of income assistance.

All told, avoided social costs for the aggregate 2009-10 student body equal approximately $50.7 million. These savings accrue for years out into the future, for as long as students remain in the workforce.

Total benefits to the public

By combining our income growth calculations with the social externalities, we are able to estimate the total benefits to the public. To these benefits we apply a reduction factor to account for the students' alternative education opportunities. The assumption is that any benefits generated by students who could have received an education elsewhere, even if Washington's community and technical colleges and the other publicly funded institutions in the state did not exist, cannot be counted as new benefits to the public.[20] For this analysis, we assume an alternative education variable of 29%, meaning that 29% of the student population at Washington's community and technical colleges would have generated benefits anyway even without the colleges. For more information on the calculation of the alternative education variable, please see Appendix 7.

We also apply an adjustment called the "shutdown point," which is designed to net out benefits that are not directly linked to the state government costs of supporting the colleges. As with the alternative education variable, the purpose of this adjustment is to account for benefits that would accrue to the public anyway. To estimate the shutdown point, we apply a sub-model that simulates the students' demand curve for education by reducing state support to zero and progressively increasing student tuition and fees. As student tuition and fees increase, enrollment declines. For Washington's community and technical colleges, the analysis shows that the colleges could not operate without state government support, and thus no

[20] A situation in which there are no public institutions in the state is virtually impossible. The adjustment is entirely hypothetical and is used merely to examine Washington's community and technical colleges in standard investment analysis terms by accounting for benefits that would have occurred anyway, even if the colleges did not exist.

discount applies. For more information on the theory and methodology behind the estimation of the shutdown point, please see Appendix 4.

Having accounted for the adjustments just described, we discount all benefits to the present using a discount rate of 3%. This yields a present value of $19.3 billion due to income growth, as indicated in Table 2.7. Also shown is a present value of $689.1 million due to future savings to the public. Altogether, the present value of all public benefits equals roughly $20 billion.

State support of Washington's community and technical colleges also appears in Table 2.7, listed as the present value of total costs. While this is technically correct, it is important to note that, unlike streams of benefits that go on into the future, the state government contribution of $1.1 billion was made in the single reporting year. Its present value and nominal dollar value are thus the same.

Table 2.7: Present value of benefits and costs, social perspective ($ thousands)

	Total
Present value of future added income	$19,269,854
Present value of future avoided social costs	$689,075
Total benefits, present value	$19,958,929
Total state government costs, present value	$1,069,808
Net present value	$18,889,121
Benefit/cost ratio	18.7

* Numbers may not add due to rounding.

Source: EMSI impact model.

Having now defined present values of costs and benefits, the model forms a benefit/cost ratio of roughly 18.7 (= $20 billion worth of benefits ÷ $1.1 billion worth of state government support). Recall that this ratio reflects the measure of all benefits generated regardless of those to whom they may accrue. Students are the beneficiaries of higher income, employers are beneficiaries of lower absenteeism and increased worker productivity, still others are beneficiaries of improved health, and so on. These are widely dispersed benefits that do not necessarily return to taxpayers, who pay costs at full measure. Inasmuch as investors and beneficiaries are not the same individuals, measures common to standard investment analyses such as rate of return, payback period, and net present value no longer apply. From the social perspective, therefore, the benefit/cost ratio should be viewed strictly as a comparison between public benefits and taxpayer costs.

Taxpayer perspective

From the taxpayer perspective, the situation is different, since investors and beneficiaries are one and the same. The pivotal step here is to limit overall public benefits shown in Tables 2.5 and 2.6 to those that specifically accrue to state and local governments. For example, benefits resulting from income growth are limited to increased state and local tax payments. Similarly, savings related to improved health, reduced crime, and fewer welfare and unemployment claims are limited to those received strictly by state and local governments. In all instances, benefits to private residents, businesses, or the federal government are excluded.

Table 2.8 presents taxpayer benefits at the students' career midpoint. Added tax revenue appears in the first row. These figures are derived by multiplying the income growth figures from Table 2.5 by the prevailing state and local government tax rates in the state. For the social externalities, we claim only those benefits where the demand for government-supported social services is reduced, or where the government benefits from improved productivity among government employees. The total undiscounted value of future tax revenues and avoided social costs at the career midpoint thus comes to approximately $107.6 million.

Table 2.8: Aggregate taxpayer benefits at students' career midpoint ($ thousands)

	Total
Added tax revenue	$103,204
Reduced government expenditures	
Health savings	$2,559
Crime savings	$1,361
Unemployment savings	$426
Total reduced government expenditures	$4,346
Total taxpayer benefits	**$107,550**

* Numbers may not add due to rounding.

Source: EMSI impact model.

Projecting the benefits in Table 2.8 out to the future and then discounting them back to the present gives the time value of all future benefit increments that accrue strictly to state and local governments. Results appear in Table 2.9. As indicated, the future stream of benefits provides an overall asset value of $1.8 billion stemming from a year's support of Washington's community and technical colleges. Costs, on the other hand, come to only $1.1 billion, equal to the annual contribution of state government to the colleges (note that this number is repeated from Table 2.7). In return for their public support, therefore, taxpayers are rewarded with an investment benefit/cost ratio of 1.7 (= $1.8 billion ÷ $1.1 billion), indicating a most profitable investment.

Table 2.9: Present value of benefits and costs, taxpayer perspective ($ thousands)

	Total
Present value of future added tax revenue	$1,730,595
Present value of future reduced government expenditures	$58,853
Total benefits, present value	$1,789,449
Total state government costs, present value	$1,069,808
Net present value	$719,640
Benefit/cost ratio	1.7
Internal rate of return	6.4%
Payback period (no. of years)	16.5

* Numbers may not add due to rounding.

Source: EMSI impact model.

At 6.4%, the rate of return to state and local taxpayers is also favorable. Economists typically assume a 3% rate of return when dealing with government investments and public finance issues. This is the return governments are assumed to be able to earn on generally safe investments of unused funds, or alternatively, the interest rate for which governments, as relatively safe borrowers, can obtain funds. A rate of return of 3% would mean that the colleges just pay their own way. In principle, governments could borrow monies used to support Washington's community and technical colleges and repay the loans out of the resulting added taxes and reduced government expenditures. A rate of return of 6.4% on the other hand, means that the colleges not only pay their own way, but they also generate a surplus that state and local governments can use to fund other programs. It is unlikely that other government programs could make such a claim.

Note that returns reported in Table 2.9 are real returns, not nominal. When a bank promises to pay a certain rate of interest on a savings account, it employs an implicitly nominal rate. Bonds operate in a similar manner. If it turns out that the inflation rate is higher than the stated rate of return, then money is lost in real terms. In contrast, a real rate of return is on top of inflation. For example, if inflation is running at 3% and a nominal percentage of 5% is paid, then the real rate of return on the investment is only 2%. In Table 2.9, the 6.4% taxpayer rate of return is a real rate. With an inflation rate of 3.1% (the average rate reported over the past 20 years as per the U.S. Department of Commerce, Consumer Price Index), the corresponding nominal rate of return is 9.5%, substantially higher than what is reported in this analysis.

With and without social benefits

Earlier in this chapter, social benefits attributable to education (reduced crime, lower welfare, lower unemployment, and improved health) are defined as externalities that are incidental to the operations of the colleges. Some would question the legitimacy of including these benefits in the calculation of rates of return to education, arguing that only direct benefits, *i.e.*, higher income, should be counted. Tables 2.7 and 2.9 are inclusive of social benefits reported here as attributable to Washington's community and technical colleges. Recognizing the other point of view, Table 2.10 shows rates of return for both the social and taxpayer perspectives exclusive of social benefits. As indicated, returns are still above threshold values (a benefit/cost ratio greater than 1 and a rate of return greater than 3%), confirming that taxpayers receive value from investing in Washington's community and technical colleges.

Table 2.10: Social and taxpayer perspectives with and without social externalities ($ thousands)

	Social perspective with socials savings…		Taxpayer perspective with social savings…	
	included	excluded	included	excluded
Net present value	$18,889,121	$18,200,046	$719,640	$660,787
Internal rate of return	n/a	n/a	6.4%	6.1%
Benefit/cost ratio	18.7	18.0	1.7	1.6
Payback period (no. of years)	n/a	n/a	16.5	16.9

Source: EMSI impact model.

Conclusion

This chapter has shown that Washington's community and technical colleges are an attractive investment to their major stakeholders—students as well as taxpayers. Rates of return to students invariably exceed alternative investment opportunities. At the same time, state taxpayers can take comfort in knowing that their expenditure of taxpayer funds creates a wide range of positive social benefits and, perhaps more importantly, actually returns more to government budgets than it costs. Without these increased tax receipts and avoided costs provided by Washington's community and technical colleges, state and local governments would have to raise taxes to make up for lost revenues and added costs.

Chapter 3: Economic Growth Analysis

Introduction

Washington's community and technical colleges promote economic growth in Washington in a variety of ways. The colleges are an employer and a buyer of goods and services. In addition, the colleges are a primary source of education to state residents and suppliers of trained workers to business and industry.

The economic impact of education may be calculated in different ways. The approach we use in this study is to express results in terms of income rather than sales, the more common measurement. The reason for this is that measuring impacts in sales terms does not account for monies that leave the economy, which makes results appear larger than they really are. Income, on the other hand, presents a more accurate picture of the colleges' actual impacts.

Results of the economic growth analysis are broken down according to the following three effects: (1) the college operations effect, stemming from the payroll and purchases of Washington's community and technical colleges; 2) the student spending effect, due to the spending of students for room and board and other personal expenses; and, (3) the productivity effect, comprising the income growth that occurs as former students from Washington's community and technical colleges deepen the economy's stock of human capital.

College operations effect

Nearly all employees of Washington's community and technical colleges live in Washington. Faculty and staff earnings become part of the state's overall income, while their spending for groceries, apparel, and other household expenditures help support businesses in the state.

In addition to being an employer, Washington's community and technical colleges are also purchasers of supplies and services. Many vendors of the colleges are located in Washington, creating a ripple effect that generates additional jobs and income throughout the economy.

Calculating the impacts

The impact of college operations is subdivided into the following two main effects: the direct effect and the indirect effect. The direct effect, equal to $1.1 billion, comprises the colleges' payroll and employee benefits (see Table 3.1). The indirect effect refers to the additional income created in the economy as college employees and the colleges' vendors and contractors spend money in the state to purchase even more supplies and services.

Estimating the indirect effect requires use of a specialized input-output (IO) model that shows the interconnection of industries, government, and households in the state. The factor of change that occurs in a state's industries as a result of economic activity in another industry is most commonly known as the multiplier. In this study, the IO model uses common "data-reduction" techniques to generate multipliers that are similar in magnitude to those of other popular IO modeling products, such as the IMPLAN and RIO models. For more information on the EMSI IO model, please see Appendix 3.

To calculate the multiplier effects, we take the payroll and purchases of Washington's community and technical colleges, map them to the 21 top-level industry sectors of the IO model, and adjust them to account for spending that occurs in-state.[21] We then run the data through the model's multiplier matrix to estimate how the colleges' spending affects the output of other industries in the state. Finally, we convert the sales figures to income by means of earnings-to-sales and value added-to-sales ratios, also provided by the IO model.

Here a qualification must be made. It has been argued that multiplier effects, such as those just described, overstate net effects. The reason is that while the economy is stimulated and incomes increase, factors of production receiving these increased incomes abandon lower paying next-best opportunities. At some level, low-level jobs may be left undone and unused capital may go to waste; or jobs may be outsourced and capital will be used overseas or elsewhere. The result is that gross multiplier effects need to be reduced to reflect this opportunity cost of taking a newly created job. Accordingly, the model applies a downward adjustment suggested by the literature and discards all but 33% of the indicated indirect impact.

The direct and indirect effects of college operations are displayed in Table 3.1. The gross total impact amounts to $1.5 billion, equal to the direct effect of the colleges' payroll plus the indirect effect of off-campus spending. These monies make up a part of Washington's overall gross state product. The lower section of the table shows the adjustment for alternative use of funds, which we discuss more fully in the following section.

[21] We collected data on the local spending patterns of some 200 sample colleges and regressed these on regional earnings to estimate the percent of college expenditures that occur locally.

Table 3.1: College operations effect, 2009-10 ($ thousands)

	Labor income	Non-labor income	Total	% of Total
Total income in state	$201,667,459	$90,233,293	$291,900,752	
Direct effect of payroll	$1,071,467	$0	$1,071,467	0.4%
Indirect effect	$327,093	$143,222	$470,315	0.2%
Gross total	$1,398,560	$143,222	$1,541,782	0.5%
Adjust for alternative fund uses	-$539,229	-$255,984	-$795,214	<0.1%
Net total	**$859,331**	**-$112,762**	**$746,568**	**0.3%**

* Numbers may not add due to rounding.

Source: EMSI impact model.

Adjusting for alternative uses of funds

Washington's community and technical colleges received an estimated 79% of their funding from sources in Washington. This funding may have come from students living in the state, in-state sales and services, or from state taxpayers. Devoting state funds to Washington's community and technical colleges means that they are not available for other uses, *e.g.*, consumer spending on the part of students or public projects on the part of government. Monies that are injected into the economy on the one hand are thus withdrawn on the other. Because of this, a portion of the colleges' impact on the economy cannot be considered as new monies brought to the state.

To determine the "net" impact of college operations, we take the estimated portion of college funding that originated from in-state sources and convert it to spending. We then bridge the spending figures to the individual sectors of the IO model, calculate the multiplier effect, and convert the amounts to income. The result, $795.2 million, allows us to see what impacts would have occurred in Washington anyway, even if the colleges did not exist. This value is subtracted from the gross effect of Washington's community and technical colleges to arrive at the true or "net" impact of college operations in the 2009-10 reporting year—a total of $746.6 million.

Student spending effect

An estimated 2% of students at Washington's community and technical colleges came from outside the U.S. and took up residence in the state while attending in the 2009-10 reporting year. Average living expenses of students appear in the first section of Table 3.2. Based on these figures, we estimate that the gross (*i.e.*, unadjusted) spending generated by international students in 2009-10 was $123.1 million. Note that this does not include expenses for books, supplies, and equipment, since many of these monies are already reflected in the operations effect discussed in the previous section.

Table 3.2: Average annual student cost of attendance and total sales generated by international students at Washington's community and technical colleges, 2009-10

Spending item	Total
Room and board	$7,341
Personal expenses	$1,895
Transportation	$1,380
Total expenses per student (actual value)	**$10,616**
Number of students at Washington's community and technical colleges who came from outside U.S. and who live in state while attending	11,592
Total gross sales in state due to the spending of international students at Washington's community and technical colleges ($ thousands)	**$123,061**

* Numbers may not add due to rounding.

Source: Student cost of attendance supplied by the College Board, "Trends in College Pricing, 2008" (The College Board, Trends in Higher Education Series, 2008). Number of international students derived from data supplied by SBCTC.

Estimating the impacts generated by the $123.1 million in student spending follows a procedure similar to that of the operations effect described above. We begin with the direct effect, which we calculate by mapping the $123.1 million in sales to the industry sectors in the IO model, adjusting them to account for leakage,[22] and then converting them to income through the application of earnings-to-sales and value added-to-sales ratios.

The indirect effect comprises the additional income that is created as the businesses patronized by international students at Washington's community and technical colleges also spend money in the state. We derive this effect by running the $123.1

[22] In arranging data for inclusion in the impact model, only the trade margin is allocated to the trade sector. Modelers customarily assume a 25% mark-up. Accordingly, an item with a retail selling price of $100 but costing the retailer $80 will enter the economic model as $20 (= $80 x 25%) to the retail trade sector, and $80 to the manufacturer of the item. If the manufacturer is located outside the region, only the $20 trade margin is added: in this case the $80 is spending that is said to "leak" from the regional economy.

million in sales (net of leakage) through the multiplier matrix, and again applying earnings-to-sales and value added-to-sales ratios from the IO model to convert the results to income.

Summing together the direct and indirect effect yields a total of $75.9 million in added income generated in Washington due to the spending of international students. This result is presented in Table 3.3.

Table 3.3: Student spending effect, 2009-10 ($ thousands)

	Labor income	Non-labor income	Total	% of Total
Total income in state	$201,667,459	$90,233,293	$291,900,752	
Direct effect	$19,921	$41,209	$61,130	<0.1%
Indirect effect	$9,598	$5,142	$14,739	<0.1%
Total	**$29,519**	**$46,350**	**$75,869**	**<0.1%**

* Numbers may not add due to rounding.

Source: EMSI impact model.

Productivity effect

The impact of Washington's community and technical colleges is most prevalent in their capacity to provide education, skills training, and career enhancement opportunities to state residents. Since the colleges were established, students have studied there and entered the workforce, bringing with them the skills they acquired while in attendance. Over time, the skills of former students from Washington's community and technical colleges have accumulated, steadily increasing the training level and experience of the Washington workforce.

As the skills embodied by former students from Washington's community and technical colleges stockpile, a chain reaction occurs in which higher student incomes generate additional rounds of consumer spending, while new skills and training translate to increased business output and higher property income, causing still more consumer purchases and multiplier effects. The sum of all these direct and indirect effects comprises the total impact of student productivity on state income.

Should Washington's community and technical colleges cease to exist, former students who remain actively engaged in the workforce would continue to contribute to the economic growth of the state through their added skills. This is what sets the productivity effect apart from the effect of college operations, which would disappear immediately, should the colleges hypothetically need to shut down. Without replenishment, however, the supply of skills in the workforce would gradually dissipate over time, and the student productivity effects would disappear along with it.

Calculating the direct effect

Assigning a dollar value to the direct effect of student productivity requires an estimation of the number of skills from Washington's community and technical colleges that are still active in the workforce, with CHEs serving as a proxy for skills. To calculate this, we begin with the historical student headcount at the colleges (both completers and non-completers) over the past 30-year period, from the 1980-81 reporting year to the 2009-10 reporting year.[23]

Of course, not all students remain in the workforce until retirement age, nor do all students enter the workforce immediately upon exiting college. Other students leave Washington and find employment outside the state. In the model, we adjust for these factors by applying yearly attrition rates derived from the probability that individuals will die, retire, or become unemployed over the course of their working careers. To these we combine migration data supplied by Washington's Community and Technical Colleges and the U.S. Census Bureau to estimate the number of students who leave Washington over time. This allows us to estimate the net number of completers and non-completers from Washington's Community and Technical Colleges who were still active in the Washington workforce in the 2009-10 reporting year.

The next step is to multiply the net number of former students who are still working in Washington by the average number of CHEs achieved per student per year (see Table 1.3). Using this methodology, the estimated number of CHEs from Washington's community and technical colleges in the state workforce comes to 118.3 million (see the top row of Table 3.4). These are the CHEs that accumulated in the workforce over the past 30-year period and that were still active in the 2009-10 reporting year.

[23] Where historical enrollment data were not available, we projected the numbers backward based on the average annual change in headcount.

Table 3.4: Number of CHEs from Washington's community and technical colleges still active in state workforce and direct added labor income (thousands)

	Total
Number of CHEs in workforce, gross	118,322
Adjust for alternative education opportunities	29%
Number of CHEs in workforce, net	84,452
Average value per CHE (actual value)	$116
Direct labor income	$9,825,873
Adjust for substitution effects	50%
Direct labor income, net	$4,912,936
Direct non-labor income	$2,493,980
Total direct income	**$7,406,916**

* Numbers may not add due to rounding.

Source: EMSI impact model.

Recall from Chapter 2 that we reduce the benefits to taxpayers by the estimated amount of benefits that would have occurred anyway even if the publicly funded training providers in the state did not exist. We apply the same adjustment here, reducing the gross number of active CHEs by 29%. This yields a net of 84.5 million CHEs that are currently embodied by former students of Washington's community and technical colleges in the state workforce.

The second half of Table 3.4 demonstrates how we arrive at the direct labor income added to the state economy due to the historical CHE production at Washington's community and technical colleges. This is a simple calculation that begins by taking the average value per CHE from Table 2.2 ($116) and multiplying it by the 84.5 million CHEs in the workforce. This yields a gross value of $9.8 billion in added labor income. We then adjust this figure downward by 50% to account for substitution effects, *i.e.*, the substitution of out-of-state workers for in-state workers.[24] The reason for this is that if the colleges did not exist and there were fewer skilled workers in the state, businesses could still recruit and hire some of their employees from outside Washington. With the 50% adjustment, the net labor income added to the economy thus comes to $4.9 billion, as shown in Table 3.4.

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[24] The 50% adjustment is an assumption—there is no way to determine precisely how many workers could have been recruited from outside the region if Washington's community and technical colleges did not exist. For a sensitivity analysis of the substitution variable, please see Chapter 4.

But there is more. Added to the direct effect on labor income is another $2.5 billion in non-labor income, representing the higher property values and increased investment income stemming from the direct income of students and enhanced productivity of the businesses that employ them. Non-labor income attributable to past student skills is obtained by disaggregating higher student income to the industrial sectors of the IO model and multiplying it by the associated value added-to-earnings ratios.[25] Summing labor and non-labor income together gives a direct effect of past student productivity equal to approximately $7.4 billion in 2009-10.

Calculating the indirect effect

Economic growth stemming from a skilled workforce does not stop with the direct effect. To calculate the indirect effect, the model allocates increases in state income to specific industrial sectors and augments these to account for both demand-side and supply-side multiplier effects. Demand-side effects refer to the increased demand for consumer goods and services as the higher incomes of skilled workers and their employers are spent in the state economy. For example, the increased output of businesses is associated with an increased demand for inputs, which in turn produces a set of economic multiplier effects that are all captured as part of demand-side indirect effects. In the model, these are estimated by converting higher student income into direct increased industry sales, running these through an indirect multiplier matrix, and converting them to state income by applying earnings-to-sales and value added-to-sales ratios supplied by the IO model.

Supply-side effects occur through a process of "cumulative causation," or "agglomeration," whereby growth becomes in some degree self-perpetuating. The presence of one industry, for example, attracts other industries that use the first industry's outputs as inputs, which produces subsequent rounds of industry growth, and so on.[26] To estimate agglomeration effects, the model converts the direct income of past students to industry value added and applies this to a set of supply-driven multipliers provided by the IO model. To increase the plausibility of this assumption,

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[25] There are twenty-one top-level industry sectors in the EMSI IO model. Disaggregating direct student earnings in this fashion avoids aggregation error. See chapter 5 in Ron Miller and Peter Blair, *Input-Output Analysis: Foundations and Extensions* (Englewood Cliffs, NJ: Prentice Hall, 1985).

[26] For a more complete discussion of agglomeration and cumulative causation, see Masahisa Fujita, Paul Krugman, and Anthony Venables, *The Spatial Economy: Cities, Regions, and International Trade* (Cambridge: Massachusetts Institute of Technology, 1999).

the model applies only direct effects associated with industries in the highest stages of development.[27]

The sum of demand-side and supply-side effects constitutes the indirect effect of student productivity, equal to $1.9 billion of all labor income and approximately $910.8 million of all non-labor income (Table 3.5). Adding these to the direct effects of student productivity yields a grand total of $10.2 billion in added income attributable to the accumulation of skills from Washington's community and technical colleges in the state workforce. This figure appears in the bottom row of Table 3.5.

Table 3.5: Student productivity effect, 2009-10 ($ thousands)

	Labor income	Non-labor income	Total	% of Total
Total income in state	$201,667,459	$90,233,293	$291,900,752	
Direct effect	$4,912,936	$2,493,980	$7,406,916	2.5%
Indirect effect	$1,908,170	$910,815	$2,818,985	1.0%
Total	**$6,821,106**	**$3,404,795**	**$10,225,902**	**3.5%**

* Numbers may not add due to rounding.

Source: EMSI impact model.

Note that the $10.2 billion omits the effect of educated workers on innovation and technical progress. This effect is generally labeled as "external" because it is uncertain in nature and spills beyond businesses employing skilled workers. For this reason it is excluded from the analysis. To the extent there are such effects, and theory suggests that there are, the overall results can be considered conservative.

Conclusion

Table 3.6 displays the grand total impact on Washington in 2009-10, including the college operations effect, the student spending effect, and the student productivity effect.

[27] Parr (1999) describes the following four stages of economic development: primary production, process manufacturing, fabricative manufacturing, and producer services and capital export. The model applies "development scores" to Parr's stages, *i.e.*, low scores for lower stage sectors and higher scores for higher development sectors. Only those industries with the highest scores are applied to the supply-driven multipliers of the IO model. For additional detail on the use of this approach for classifying industries by industrial stage, see Rutgers *et al*, 2002.

Table 3.6: Total effect, 2009-10 ($ thousands)

	Total	% of Total
Total income in state	$291,900,752	
College operations effect	$746,568	0.3%
Student spending effect	$75,869	<0.1%
Student productivity effect	$10,225,902	3.5%
Total	**$11,048,339**	**3.8%**

* Numbers may not add due to rounding.

Source: EMSI impact model.

These results demonstrate several important points. First, Washington's community and technical colleges promote state economic growth through their own operations spending and through the increase in productivity as former students of the colleges remain active in the state workforce. Second, the student productivity effect is by far the largest and most important impact of the colleges, stemming from higher incomes of students and their employers. And third, state income in Washington would be substantially lower without the educational activities of the colleges.

Chapter 4: Sensitivity Analysis

Introduction

This study concludes with a sensitivity analysis of some key variables on both the economic growth and investment analysis sides. The purpose of the sensitivity analysis is to set the approach apart from "advocacy" education impact analyses that promote education. These studies often use assumptions that do not stand up to rigorous peer scrutiny and generate results that overstate benefits. The approach here is to account for relevant variables in calculating benefits and costs as reflected in the conservatively estimated base case assumptions laid out in Chapters 2 and 3.

The sensitivity tests include the following: a) the impacts associated with changes in the student employment variables for the investment analysis, b) the sensitivity of results associated with the alternative education variable, c) the sensitivity of results associated with the substitution variable, and d) the sensitivity of results to changes in state funding levels.

Student employment variables

Student employment variables are difficult to estimate either because many students do not report their employment status or because colleges generally do not collect this kind of information. Employment variables include the following: 1) the percentage of students employed, and 2) of those employed, what percentage they earn relative to earnings they would have received if they were not attending Washington's community and technical colleges. Both employment variables relate to earnings forgone by students, *i.e.*, the opportunity cost of time; and they affect the investment analysis results (net present value, rate of return, benefit/cost ratio, and payback period).

Percent of students employed

Students incur substantial expense by attending Washington's community and technical colleges because of the time they spend not gainfully employed. Some of that cost is recaptured if students remain partially (or fully) employed while attending. It is estimated that 44% of students who reported their employment status are employed, based on data provided by SBCTC. This variable is tested in the sensitivity analysis by changing it first to 100% and then to 0%.

Percent of earnings relative to full earnings

The second opportunity cost variable is more difficult to estimate. For Washington's community and technical colleges, it is estimated that students working while attending classes earn only 67%, on average, of the earnings they would have statistically received if not attending college. This suggests that many students hold part-time jobs that accommodate their college attendance, though it is at an additional cost in terms of receiving a wage that is less than what they might otherwise make. The model captures these differences and counts them as part of the opportunity cost of time. As above, this variable is tested in the sensitivity analysis by changing the assumption to 100% and then to 0%.

Results

The changed assumptions generate results summarized in Table 4.1, with "A" defined as the percent of students employed and "B" defined as the percent that students earn relative to their full earning potential. Base case results appear in the shaded row – here the assumptions remain unchanged, with A equal to 44% and B equal to 67%. Sensitivity analysis results are shown in non-shaded rows. Scenario 1 increases A to 100% while holding B constant, Scenario 2 increases B to 100% while holding A constant, Scenario 3 increases both A and B to 100%, and Scenario 4 decreases both A and B to 0%.

Table 4.1: Sensitivity analysis of student perspective

Variables	Rate of Return	Benefit/Cost	Payback
Base case: A = 44%, B = 67%	20.8%	5.9	7.1
Scenario 1: A = 100%, B = 67%	26.3%	8.0	5.8
Scenario 2: A = 44%, B = 100%	23.6%	6.9	6.4
Scenario 3: A = 100%, B = 100%	43.4%	14.7	4.0
Scenario 4: A = 0%, B = 0%	17.9%	4.8	8.0

Note: A = percent of students employed; B = percent earned relative to statistical averages

1. Scenario 1: Increasing the percent of students employed (A) from 44% to 100%, the rate of return, benefit/cost ratio, and payback period results improve to 26.3%, 8.0, and 5.8 years, respectively, relative to base case results. Improved results are attributable to a lower opportunity cost of time—all students are employed in this case.
2. Scenario 2: Increasing earnings relative to statistical averages (B) from 67% to 100%, the rate of return, benefit/cost ratio, and payback period results improve to 23.6%, 6.9, and 6.4 years, respectively, relative to base

case results—a strong improvement, again attributable to a lower opportunity cost of time.

3. Scenario 3: Increasing both assumptions A and B to 100% simultaneously, the rate of return, benefit/cost ratio, and payback period results improve yet further to 43.4%, 14.7, and 4.0 years, respectively, relative to base case results. This scenario assumes that all students are fully employed and earning full salaries (equal to statistical averages) while attending classes.

4. Scenario 4: Finally, decreasing both A and B to 0% reduces the rate of return, benefit/cost ratio, and payback period results to 17.9%, 4.8, and 8.0 years, respectively, relative to base case results. These results are reflective of an increased opportunity cost—none of the students are employed in this case.[28]

It is strongly emphasized in this section that base case results are very attractive in that results are all above their threshold levels, and payback periods are short. As is clearly demonstrated here, results of the first three alternative scenarios appear much more attractive, although they overstate benefits. Results presented in Chapter 2 are realistic, indicating that investments in Washington's community and technical colleges generate excellent returns, well above the long-term average percent rates of return in stock and bond markets.

Alternative education variable

The alternative education variable (29%) is characterized as a "negative benefit" used to account for students who can obtain a similar education elsewhere absent the publicly funded training providers in the state. Given the difficulty in accurately specifying the alternative education variable, the obvious question is the following: how great a role does it play in the magnitude of the results?

Variations in the alternative education assumption are calculated around base case results listed in the middle column of Table 4.2. Next, the model brackets the base case assumption on either side with a plus or minus 17%, 33%, and 50% variation in assumptions. Analyses are then redone introducing one change at a time, holding all other variables constant. For example, an increase of 17% in the alternative education assumption (from 29% to 33%) reduces the taxpayer perspective rate of return from

[28] Note that reducing the percent of students employed to 0% automatically negates the percent they earn relative to full earning potential, since none of the students receive any earnings in this case.

6.4% to 6.0%. Likewise, a decrease of 17% (from 29% to 24%) in the assumption increases the rate of return from 6.4% to 7.0%.

Table 4.2: Sensitivity analysis of alternative education variable, taxpayer perspective ($ millions)

	-50%	-33%	-17%	Base Case	17%	33%	50%
Alternative education variable	14%	19%	24%	29%	33%	38%	43%
Net present value	$1,129.7	$1,007.2	$884.8	$719.6	$639.9	$517.4	$394.9
Rate of return	7.9%	7.5%	7.0%	6.4%	6.0%	5.5%	5.0%
Benefit/cost ratio	2.1	1.9	1.8	1.7	1.6	1.5	1.4
Payback period (years)	14.4	14.9	15.5	16.5	17.0	17.8	18.8

Based on this sensitivity analysis, the conclusion can be drawn that investment analysis results from the taxpayer perspective are not very sensitive to relatively large variations in the alternative education variable. As indicated, results are still above their threshold levels (net present value greater than 0, benefit/cost ratio greater than 1, and rate of return greater than the discount rate of 3%) even when the alternative education assumption is increased by as much as 50% (from 29% to 43%). The conclusion is that although the assumption is difficult to specify, its impact on overall investment analysis results for the taxpayer perspective is not very sensitive.

Substitution variable

The substitution variable only affects the student productivity calculation in Table 3.5. In the model we assume a substitution variable of 50%, which means that we claim only 50% of the direct labor income generated by increased worker productivity. The other 50% we assume would have occurred even if Washington's community and technical colleges did not exist. This is because, if there were no students from the colleges to hire, some businesses could have recruited similarly qualified individuals from outside the state.

Table 4.3 presents the results of the sensitivity analysis for the substitution variable. As above, the assumption increases and decreases relative to the base case of 50% by the increments indicated in the table. Impacts on the results are more pronounced. Student productivity effects attributable to the colleges, for example, range from a high of $15.3 billion at 50% to a low of $5.1 billion at a -50% variation from the base case assumption for this variable. This means that if the substitution variable were to decrease, the number of benefits that we claim also decreases; hence, the income attributable to the colleges decreases accordingly.

Table 4.3: Sensitivity analysis of substitution variable on student productivity ($ millions)

	-50%	-33%	-17%	Base Case	17%	33%	50%
Substitution variable	25%	33%	42%	50%	58%	67%	75%
Student productivity effect	$5,113	$6,817	$8,522	$10,226	$11,930	$13,635	$15,339
Total effect	$5,935	$7,640	$9,344	$11,048	$12,753	$14,457	$16,161
Percent of state income	2.0%	2.6%	3.2%	3.8%	4.4%	5.0%	5.5%

It is important to note that, even under the most conservative assumptions, the total effect of Washington's community and technical colleges — including the effects of college operations, student spending, and student productivity — still remains a sizeable factor in the Washington economy. The college operations effect and the student spending effect are kept constant for this sensitivity analysis, so the variations in the total effect are caused solely by the changes to student productivity in the second row. The last row of the table shows the percent of total state income that is attributable to the colleges and their former students.

State taxpayer cost variables

Here we assess the sensitivity of the investment analysis results to increases or decreases in state funding. As funding levels change, the colleges' ability to serve students also varies. With adequate funding, colleges are able to provide space, faculty, and services to their students while keeping tuition and fees at affordable prices. This encourages more students to attend. With reduced funding, however, colleges must apply increasingly stringent cost controls and either raise tuition and fees, limit enrollment, or cut programs and services. These actions translate to either fewer students served or a reduction in the quality of the education provided. In either case, benefits generated by the colleges and their students are also reduced.

Results of the analysis appear in Table 4.4, with a plus or minus 5% and 10% change in funding levels. Changes in enrollment are estimated based on the "shutdown point" model that simulates the effect on student attendance should the colleges sustain a reduction in state funding (see Appendix 4 for more information). The base case scenario in the center column matches the social and taxpayer perspective investment analysis results that appear in Chapter 2. In this scenario we assume that, if current funding levels for Washington's community and technical colleges continue into the future, the economic benefits generated by colleges and their students will also remain about the same.

Table 4.4: Sensitivity analysis of state taxpayer cost variables ($ millions)

	-10%	-5%	Base Case	5%	10%
State funding	$962.8	$1,016.3	$1,069.8	$1,123.3	$1,176.8
Number of students served	436,854	453,145	469,907	480,424	496,062
Annual benefits to the public at large					
Taxable income	$1,068.3	$1,108.2	$1,149.2	$1,174.9	$1,213.1
Avoided social costs	$47.1	$48.9	$50.7	$51.8	$53.5
Annual benefits to state and local government					
Added taxes collected	$95.9	$99.5	$103.2	$105.5	$108.9
Reduced gov't expenditures	$4.0	$4.2	$4.3	$4.4	$4.6
Return on investment, taxpayer perspective					
Rate of return	6.6%	6.5%	6.4%	6.2%	6.1%
Benefit/cost ratio	1.7	1.7	1.7	1.6	1.6
Payback period	16.1	16.3	16.5	16.7	16.9

A 10% increase in state taxpayer funding would allow for an increased enrollment of 26,155 credit and non-credit students, equal to 496,062 students less the 469,907 students in the base case scenario. More students served means that more students will enter the workforce with added skills, thereby increasing their earning potential. This in turn will yield associated increases in taxable income throughout the state, along with more savings to the public as crime rates go down, public health improves, and the number of welfare and unemployment claims decreases.

Looking at the worst case scenario—a 10% reduction in funding—the following consequences would unfold. State taxpayers would initially save $107 million, but the colleges would serve 33,053 fewer students. Taxable income in the state would be approximately $80.8 million lower each year, while social costs would increase by about $3.6 million each year (due to higher crime rates, increased health costs, and a higher number of welfare and unemployment claims). And, finally, the Washington tax base would be approximately $7.3 million smaller each year, while the annual demand for government-supported social services would increase by $0.3 million.

Variations in the investment analysis results appear in the bottom section of Table 4.4. As shown, the rate of return and benefit/cost ratio from the taxpayer perspective slightly increase as funding levels decrease. This is because the benefits to taxpayers do not increase or decrease at the same rate as the cost measures do. However, there is a crossover point at which, if funding levels drop below that threshold, the benefits to taxpayers drop precipitously. Further research must be done to determine that that threshold is (all else being equal). It should also be noted that, although the rates of return increase at lower funding levels, the corresponding benefits that accrue to taxpayers decrease, meaning that the revenues collected by taxpayers as a result of their investment are actually lower.

Conclusion

The results of this study demonstrate that Washington's community and technical colleges are a sound investment from multiple perspectives. The colleges enrich the lives of students and increase their lifetime incomes. They benefit taxpayers by generating increased tax revenues from an enlarged economy and reducing the demand for taxpayer-supported social services. Finally, they contribute to the vitality of the state and local economies.

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Appendix 2: Glossary of Terms

Alternative education	A "with" and "without" measure of the percent of students who would still be able to avail themselves of education absent the publicly funded educational institutions in the state. An estimate of 10%, for example, means that 10% of students do not depend directly on the existence of the college in order to obtain their education.
Alternative use of funds	A measure of how monies that are currently used to fund the college might have been used if the college did not exist.
Asset value	Capitalized value of a stream of future returns. Asset value measures what someone would have to pay today for an instrument that provides the same stream of future revenues.
Attrition rate	Rate at which students leave the local region due to out-migration, retirement, or death.
Benefit/cost ratio	Present value of benefits divided by present value of costs. If the benefit/cost ratio is greater than 1, then benefits exceed costs, and the investment is feasible.
Credit hour equivalent	Credit hour equivalent, or CHE, is defined as 15 contact hours of education if on a semester system, and 10 contact hours if on a quarter system. In general, it requires 450 contact hours to complete one full time equivalent, or FTE.
Demand	Relationship between the market price of education and the volume of education demanded (expressed in terms of enrollment). The law of the downward-sloping demand curve is related to the fact that enrollment increases only if the price (student tuition and fees) is lowered, or conversely, enrollment decreases if price increases.
Direct effect	Jobs and income directly generated by the college and its students.

Discounting	Expressing future revenues and costs in present value terms.
Economics	Study of the allocation of scarce resources among alternative and competing ends. Economics is not normative (what ought to be done), but positive (describes what is, or how people are likely to behave in response to economic changes).
Elasticity of demand	Degree of responsiveness of the quantity of education demanded (enrollment) to changes in market prices (student tuition and fees). If a decrease in fees increases total revenues, demand is elastic. If it decreases total revenues, demand is inelastic. If total revenues remain the same, elasticity of demand is unitary.
Externalities	Impacts (positive and negative) for which there is no compensation. Positive externalities of education include improved social behaviors such as lower crime, reduced unemployment, and improved health. Educational institutions do not receive compensation for these benefits, but benefits still occur because education is statistically proven to lead to improved social behaviors.
Gross State Product	Measure of the final value of all goods and services produced. Alternatively, GSP equals the combined incomes of all factors of production, *i.e.*, labor, land and capital. These include wages, salaries, proprietors' incomes, profits, rents, and other.
Indirect effect	Jobs and income that result from the direct spending of the college and its students.
Input-output analysis	Relationship between a given set of demands for final goods and services, and the implied amounts of manufactured inputs, raw materials, and labor that this requires. In an educational setting, when universities pay wages and salaries and spend money for supplies in the local region, they also generate earnings in all sectors of the economy, thereby increasing the demand for goods and services and jobs. Moreover, as

	students enter or rejoin the workforce with higher skills, they earn higher salaries and wages. In turn, this generates more consumption and spending in other sectors of the economy.
Internal rate of return	Rate of interest which, when used to discount cash flows associated with investing in education, reduces its net present value to zero (*i.e.*, where the present value of revenues accruing from the investment are just equal to the present value of costs incurred). This, in effect, is the breakeven rate of return on investment since it shows the highest rate of interest at which the investment makes neither a profit nor a loss.
Labor income	Income which is received as a result of labor, *i.e.*, wages.
Multiplier	The number of times a dollar cycles through the economy, generating additional income and jobs, before leaving the economy. Therefore, a multiplier of 1.7 estimates that a dollar will generate an additional $0.70 in the economy before leaving.
Net cash flow	Benefits minus costs, *i.e.*, the sum of revenues accruing from an investment minus costs incurred.
Net present value	Net cash flow discounted to the present. All future cash flows are collapsed into one number, which, if positive, indicates feasibility. The result is expressed as a monetary measure.
Non-labor income	Income which is received from investments (such as rent, interest, and dividends) and transfer payments (payments from governments to individuals).
Opportunity cost	Benefits forgone from alternative B once a decision is made to allocate resources to alternative A. Or, if an individual chooses not to attend the college, he or she forgoes higher future earnings associated with education. The benefit of education, therefore, is the “price tag” of choosing not to attend the college.
Payback period	Length of time required to recover an investment—the shorter the period, the more attractive the investment.

Appendix 3: EMSI Input-Output Model

Introduction and data sources

EMSI's input-output model represents the economic relationships among a region's industries, with particular reference to how much each industry purchases from each other industry. Using a complex, automated process, we can create regionalized models for geographic areas comprised by counties or ZIP codes in the United States.

Our primary data sources are the following:

1. The Industry Economic Accounts from the Bureau of Economic Analysis (BEA); specifically the "make" and "use" tables from the annual and benchmark input-output accounts.
2. Regional and national jobs-by-industry totals, and national sales-to-jobs ratios (from EMSI's industry employment and earnings data process).
3. Proprietor earnings from State and Local Personal Income Reports (BEA).

Creation of the national Z matrix

The BEA "make" and "use" tables (MUTs) show which industries make or use which commodity types. These two tables are combined to replace the industry-commodity-industry relationships with simple industry-industry relationships in dollar terms. This is called the national "Z" matrix, which shows the total amount ($) each industry purchases from others. Industry purchases run down the columns, while industry sales run across the rows.

Table 1: Sample "Z" matrix ($ millions)

	Industry 1	Industry 2	. . .	Industry N
Industry 1	3.3	1,532.5	. . .	232.1
Industry 2	9.2	23.0	. . .	1,982.7
. . .	. . .	. . .	. . .	. . .
Industry N	819.3	2,395.6	. . .	0

The value 1,532.5 in this table means that Industry 2 purchases $1,532,500,000 worth of commodities and/or services from Industry 1.

The whole table is basically an economic double-entry accounting system, configured so that all money inflows have corresponding outflows elsewhere.

In addition to regular industries (such as "oil and gas extraction," "machinery manufacturing," "food and beverage stores," "hospitals," and so on), there are three additional rows representing labor earnings, profits, and business taxes, which together represent industry "value added" and account for the fact that industries do not spend all of their income on inputs from other industries. There are also three rows and columns representing federal, state, and local government (we later separate federal government into civilian and military sectors).

We create two separate Z matrices since there are two sets of MUTs—annual and benchmark. The benchmark data are produced every five years with a five-year lag and specify up to 500 industry sectors; annual data have a one-year lag but specify only 80 industrial sectors.

The basic equation is as follows:

$Z = VQ\hat{}-1U$

where V is the industry "make" table, $Q\hat{}-1$ is a vector of total gross commodity output, and U is the industry "use" table.

In reality, this equation is more complex because we also need to "domesticate" the Z matrix by removing all imports. This is needed because we are creating a "closed" type of national model.

In addition, there are a number of modifications that need to be made to the BEA data before the calculations can begin. These are almost all related to the conversion of certain data in BEA categories to new categories that are more compatible with other data sets we use in the process, and describing them in detail is beyond the scope of this document.

Disaggregation of the national Z matrix

The previous step resulted in two national Z matrices—one based on the benchmark BEA data (five years old, approximately 500 industries) and the other based on the annual BEA data (one year old, but only about 80 industries). These initial national Z matrices are then combined and disaggregated to 1,125 industry sectors. Combining them allows us to capitalize on both the recency of the annual data and the detail of the benchmark data. The disaggregation is performed for each initial Z matrix using probability matrices that allow us to estimate industry transactions for the more detailed sectors based on the known transactions of their parent sectors. The probability matrix is created from detailed EMSI industry earnings data, which are available for all 1,125 sectors and are created using a separate process.

Creation of the national A matrix

The national disaggregated Z matrix is then "normalized" to show purchases as percentages of each industry's output rather than total dollar amounts. This is called the national "A" matrix.

Table 2: Sample "A" matrix

	Industry 1	Industry 2	. . .	Industry 1125
Industry 1	.001	.112	. . .	.035
Industry 2	.097	0	. . .	.065
. . .	. . .	. . .	. . .	. . .
Industry 1125	.002	.076	. . .	0

Each cell value represents the percentage of a row industry's output that goes toward purchasing inputs from each column industry. Thus, the cell containing .112 above means that Industry 1 spends 11.2% of its total output to obtain inputs from Industry 2.

At this point, our additional rows representing earnings, profits, and business taxes are removed. However, we will use them in a different form later.

Regionalization of the A matrix

To create a regional input-output model, we regionalize the national A matrix using that region's industry mix.

The major step in the process is the calculation of per-industry out-of-region exports. This is performed using a combination of the following standard techniques that are present in the academic literature:

1. Stevens regional purchase coefficients (RPCs)
2. Simple location quotient of value added sales
3. Supply/demand pools derived from the national A matrix

We try to maximize exports in order to account as fully as possible for "cross-hauling," which is the simultaneous export and import of the same good or service to/from a region, since it is quite common in most industries.

Another major part of the process is the regionalization of consumption, investment, and local government "row industries" (rows referring to the rows of the A matrix). These represent the percentage of each industry's sales that end up going toward consumption, capital purchases, and taxes to local government, respectively. They are created from the "value added" rows that we removed earlier. Consumption is calculated using each industry's earnings and profits, as well as a constant called "the average propensity to consume," which describes the approximate percentage of earnings and profits that are spent on consumption. Investment and local government rows are calculated by distributing the known total investment and endogenous local government for the entire region to individual industries proportionally to their value added.

The A-matrix regionalization process is automated for any given region for which industry data are available. Although partially derived from national figures, the regional A matrix offers a best possible estimate of regional values without resorting to costly and time-consuming survey techniques, which in most cases are completely infeasible.

Creating multipliers and using the A matrix

Finally, we convert the regional "A" matrix to a "B" matrix using the standard Leontief inverse $B = (I - A) - 1$. The "B" matrix consists of inter-industry sales multipliers, which can be converted to jobs or earnings multipliers using per-industry jobs-to-sales or earnings-to-sales ratios.

The resulting tables and vectors from this process are then used in the actual end-user software to calculate regional requirements, calculate the regional economic base, estimate sales multipliers, and run impact scenarios.

Appendix 4: Shutdown Point

Introduction

The investment analysis weighs benefits of enrollment (measured in terms of CHEs) against the support provided by state government. This adjustment factor is used to establish a direct link between the costs of supporting the college and the benefits it generates in return. If benefits accrued without taxpayer support, then it would not be a true investment.[29]

The overall approach includes a sub-model that simulates the effect on student enrollment should the college lose its state funding and have to raise student tuition and fees in order to stay open. If the college can still operate without state support, then any benefits it generates at that level are discounted from total benefit estimates. If the simulation indicates that the college cannot stay open, however, then benefits are directly linked to costs, and no discounting applies. This appendix documents the procedure for making these adjustments.

State government support versus student demand

Figure 1 presents a simple model of student demand and state government support. The right side of the graph is a standard demand curve (D) showing student enrollment as a function of student tuition and fees. Enrollment is measured in terms of total CHEs generated and expressed as a percentage of current CHE production. Current student tuition and fees are represented by p', and state government support covers C% of all costs. At this point in the analysis, it is assumed that the college has only two sources of revenues: (1) student tuition and fees, and; (2) state government support.

[29] Of course, as public training providers, Washington's community and technical colleges would not be permitted to continue without public funding, so the situation in which they would lose all state support is entirely hypothetical. The purpose of the adjustment factor is to examine Washington's community and technical colleges in standard investment analysis terms by netting out any benefits they may be able to generate that are not directly linked to the costs of supporting them.

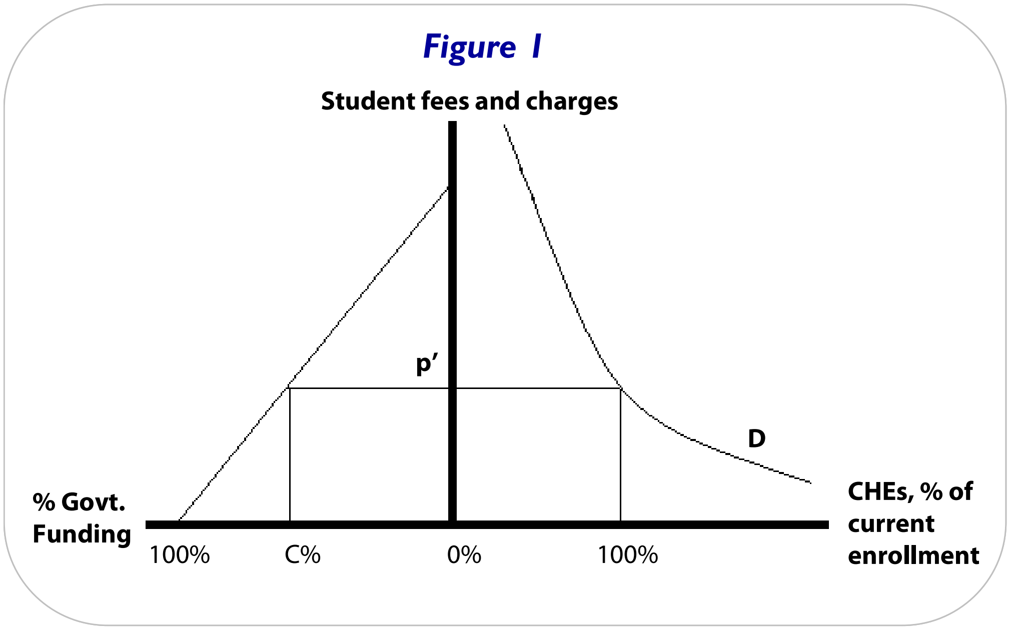
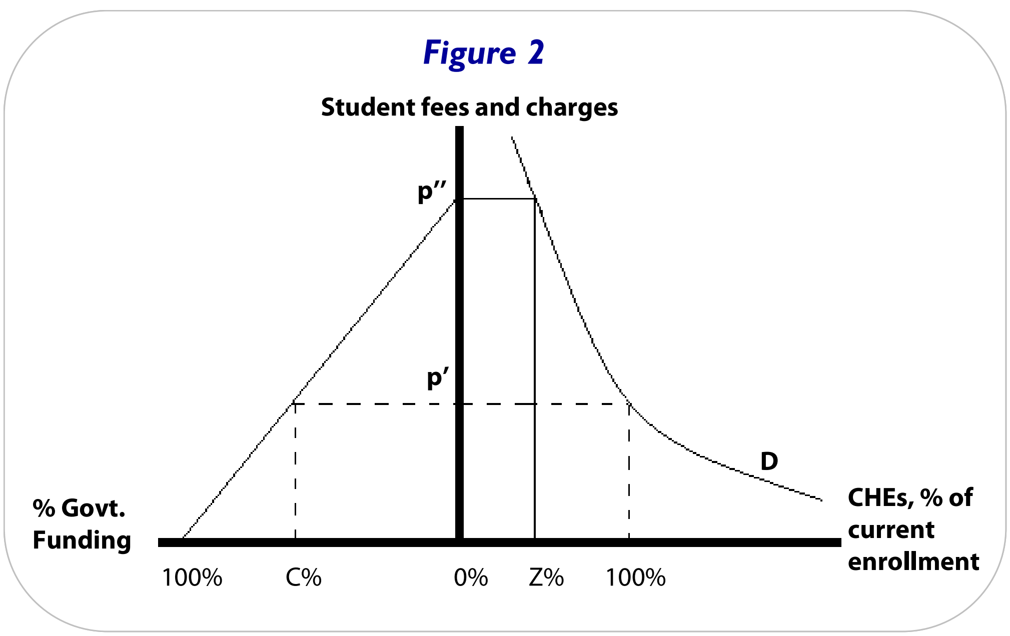


Figure 2 shows another important reference point in the model—where state government support is 0%, student tuition and fees are increased to p", and enrollment is Z% (less than 100%). The reduction in enrollment reflects price elasticity in the students' education vs. no-education decision. Neglecting for the moment those issues concerning the college's minimum operating scale (considered below in the section called "Shutdown Point"), the implication for the investment analysis is that benefits of state support must be adjusted to net out benefits associated with a level of enrollment at Z% (*i.e.*, the college can provide these benefits absent state support).



From enrollment to benefits

This appendix focuses mainly on the size of enrollment (*i.e.*, CHE production) and its relationship to student versus state funding. However, to clarify the argument it is useful to briefly consider the role of enrollment in the larger benefit/cost model.

Let B equal the benefits attributable to state support. The analysis derives all benefits as a function of student enrollment (*i.e.*, CHE production). For consistency with the graphical exposition elsewhere in this appendix, B is expressed as a function of the percent of current enrollment (*i.e.*, percent of current CHE production). Accordingly, the equation

1) $B = B\ (100\%)$

reflects the total benefits generated by enrollments at their current levels.

Consider benefits now with reference to Figure 2. The point at which state support is zero nonetheless provides for Z% (less than 100%) of the current enrollment, and benefits are symbolically indicated by the following equation:

2) $B = B\ (Z\%)$

Inasmuch as the benefits in (2) occur with or without state support, the benefits appropriately attributed to state support are given by the following equation:

3) $B = B\ (100\%) - B\ (Z\%)$

Shutdown point

College operations cease when fixed costs can no longer be covered. The shutdown point is introduced graphically in Figure 3 as S%. The location of point S% indicates that the college can operate at an even lower enrollment level than Z% (the point of zero state funding). At point S%, state support is still zero, and the student tuition and fees have been raised to p'''. With student tuition and fees still higher than p''', the college would not be able to attract enough students to keep the doors open, and it would shut down. In Figure 3, point S% illustrates the shutdown point but otherwise plays no role in the estimation of taxpayer benefits. These remain as shown in equation (3).

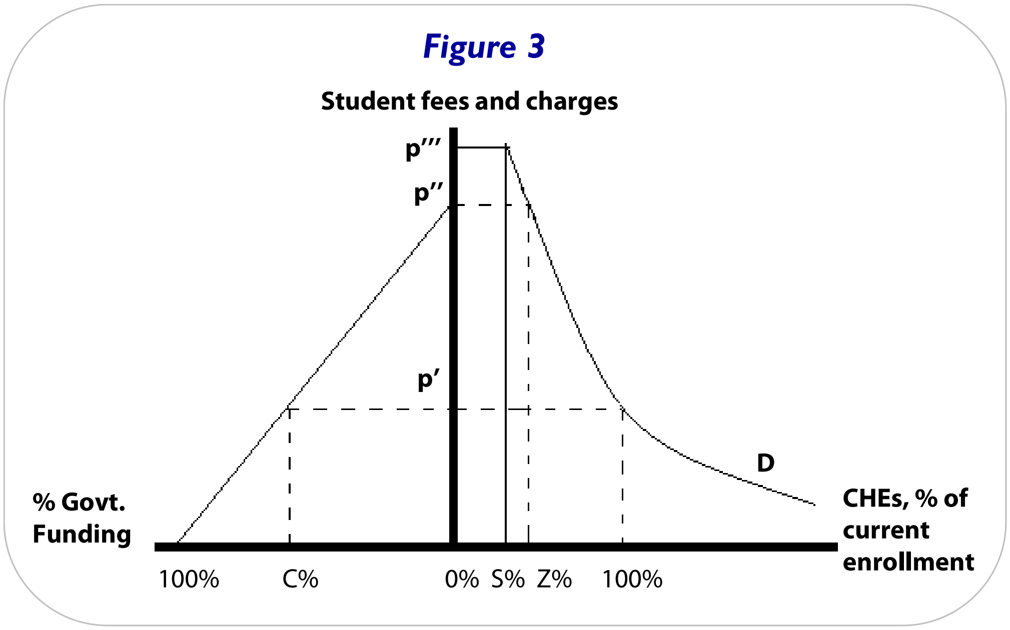
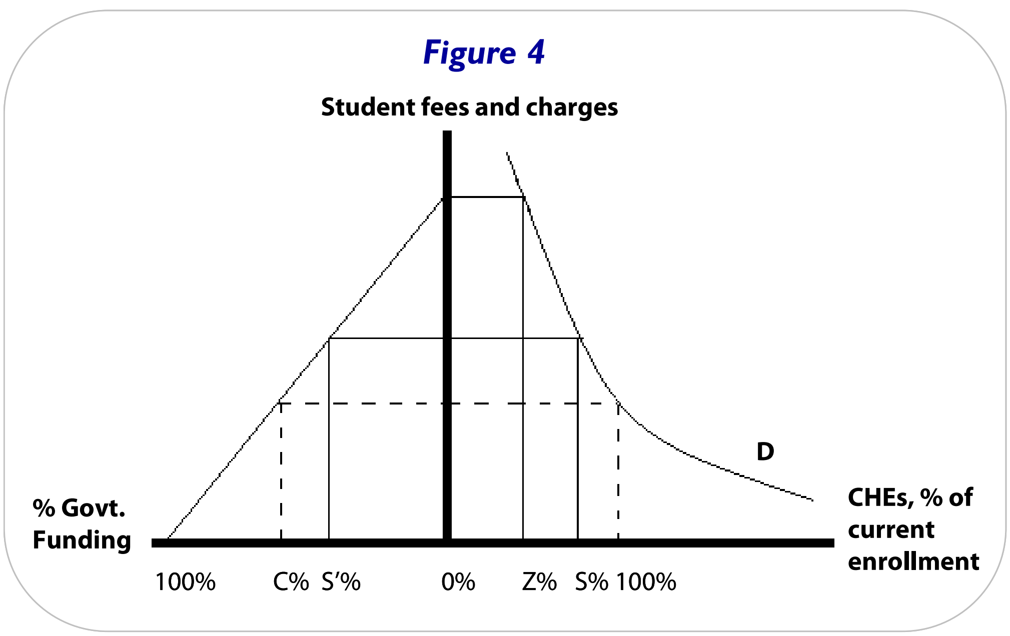


Figure 4 illustrates yet another scenario. Here the shutdown point occurs at an enrollment level greater than Z% (the level of zero state support), meaning some minimum level of state support is needed for the college to operate at all. This minimum portion of overall funding is indicated by S'% on the left side of the chart, and as before, the shutdown point is indicated by S% on the right side of chart. In this case, state support is appropriately credited with all the benefits generated by enrollment, or B = B (100%).



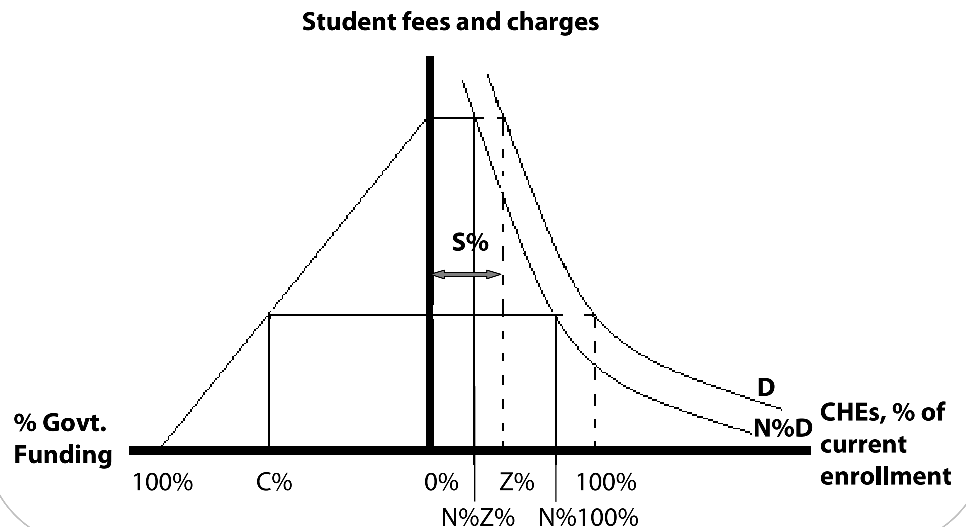
Adjusting for alternative education opportunities

Because some students may be able to avail themselves of an education even without the publicly funded training providers in the state, the benefits associated with these students must be deducted from the overall benefit estimates. The adjustment for alternative education is easily incorporated into the simple graphic model. For simplicity, let A% equal the percent of students with alternative education opportunities, and let N% equal the percent of students without an alternative. Note that N% + A% = 100%.

Figure 5 presents the case where the college could operate absent state support (*i.e.*, Z% occurs at an enrollment level greater than the shutdown level S%). In this case, the benefits generated by enrollments absent state support must be subtracted from total benefits. This case is parallel to that indicated in equation (3), and the net benefits attributable to state support are given by the following equation:

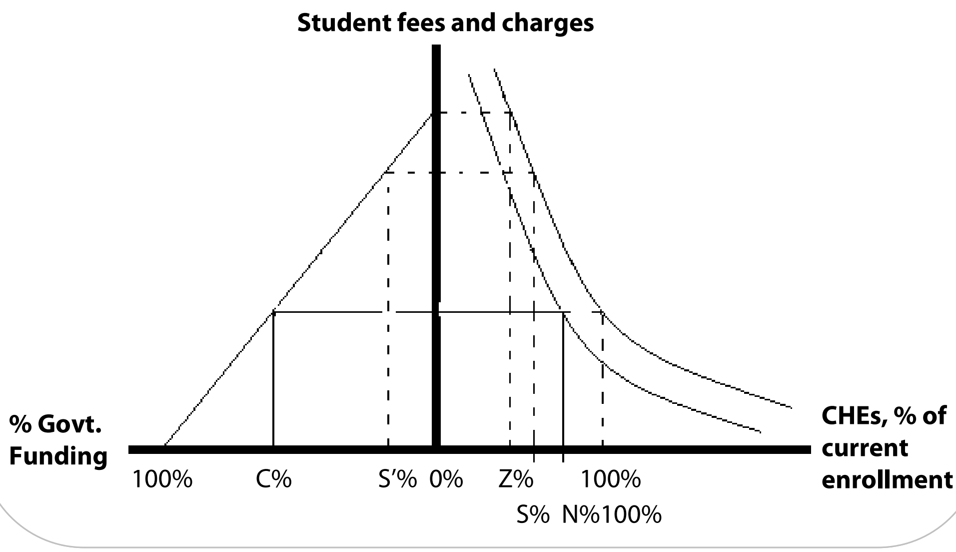
4) $B = B(N\% \times 100\%) - B(N\% \times Z\%)$

Figure 5



Finally, Figure 6 presents the case where the college cannot remain open absent some minimum S'% level of state support. In this case, taxpayers are credited with all benefits generated by current enrollment, less only the percent of students with alternative education opportunities. These benefits are represented symbolically as B (N% × 100%).

Figure 6


Student fees and charges
% Govt.
Funding
CHEs, % of
current
enrollment
100%
C%
S'%
0%
Z%
100%
S%
N%100%

Appendix 5: Social Externalities

Introduction

Education has a predictable and positive effect on a diverse array of social benefits. These, when quantified in dollar terms, represent significant avoided social costs that directly benefit the public as whole, including taxpayers. In this appendix we discuss the following three main benefit categories: 1) improved health, 2) reductions in crime, and 3) reductions in unemployment and welfare.

It is important to note that the data and estimates presented here should not be viewed as exact, but rather as indicative of the positive impacts of education on an individual's quality of life. The process of quantifying these impacts requires a number of assumptions to be made, creating a level of uncertainty that should be borne in mind when reviewing the results.

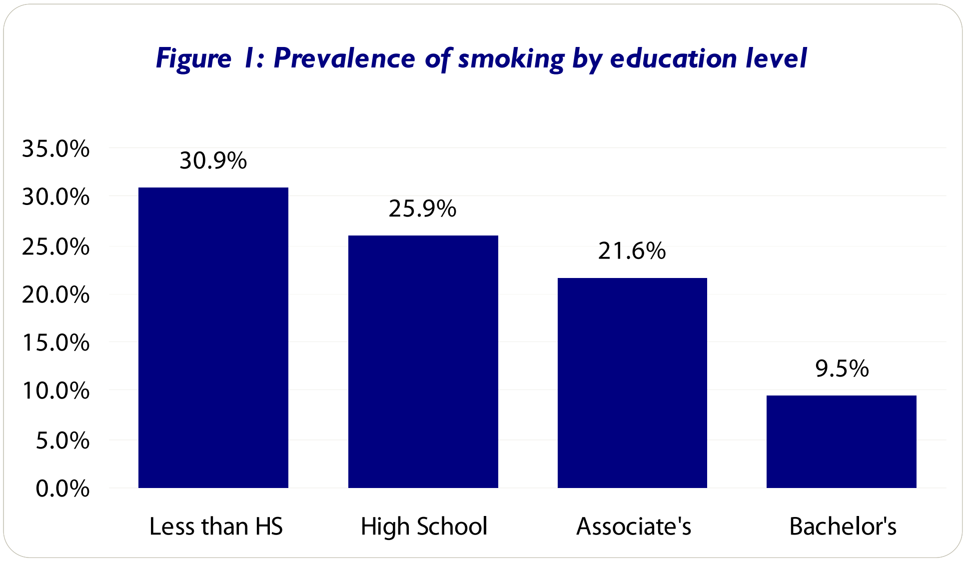
Health

Statistics clearly show the correlation between increases in education and improved health. The manifestations of this are found in two health-related variables, smoking and alcohol. There are probably several other health-related areas that link to educational attainment, but these are omitted from the analysis until we can invoke adequate (and mutually exclusive) databases and are able to fully develop the functional relationships.

Smoking

Despite declines over the last several decades in the percentage of the U.S. population who smoke, a sizeable percentage of the U.S. population still use tobacco. The negative health effects of smoking are well documented in the literature, which identifies smoking as one of the most serious health issues in the United States.

Figure 1 reports the prevalence of cigarette smoking among adults aged 25 years and over, based on data provided by the National Health Interview Survey. As indicated, the percent of persons who smoke cigarettes begins to decline beyond the level of high school education.



The CDC reports the percent of adults who are current smokers by state.[30] We use this information to create an index value by which we adjust the national prevalence data on smoking to each state. For example, 20.1% of Ohio's adults were smokers in 2008, relative to 18.3% for the nation. We thus apply a scalar of 1.1 to the national probabilities of smoking in order to adjust them to the state of Ohio.

Alcohol

Alcoholism is difficult to measure and define. There are many patterns of drinking, ranging from abstinence to heavy drinking. Alcohol abuse is riddled with social costs, including health care expenditures for treatment, prevention and support; workplace losses due to reduced worker productivity and premature mortality; and other costs related to vehicle crashes, fire destruction, and social welfare administration.

Figure 2 presents the percent of the adult population that are heavy drinkers, by gender and education level.[31] These statistics give an indication of the correlation between education and the reduced probability of alcohol abuse. As indicated, heaving drinking among males falls from a 16% prevalence rate among individuals with fewer than 12 years of education, to an 11% prevalence rate among individuals with more than 12 years of education. The probability of being a heavy drinker also falls on a sliding scale for women, from 5% to 3%. Note that women are less likely to be heavy drinkers than men.

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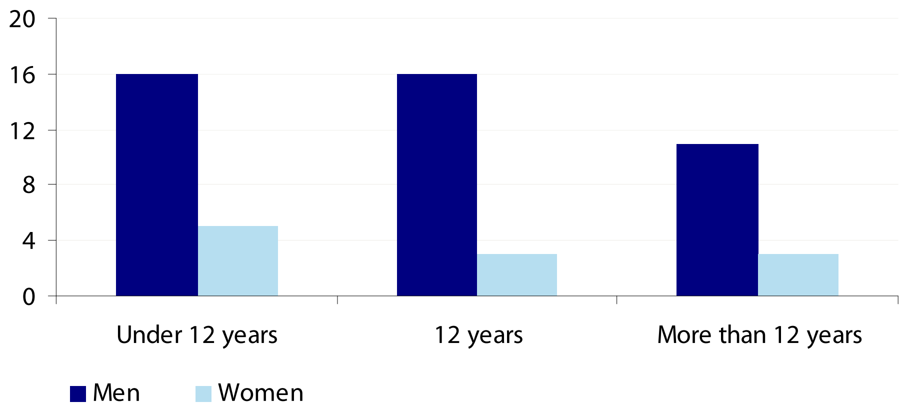
[30] Center for Disease Control and Prevention (CDC), Prevalence and Trends Data, Tobacco Use - 2008, Adults who are current smokers (accessed June 2009).

[31] Data are supplied by the National Institute of Alcohol Abuse and Alcoholism.

Figure 2: Prevalence of heavy drinking by gender and education level

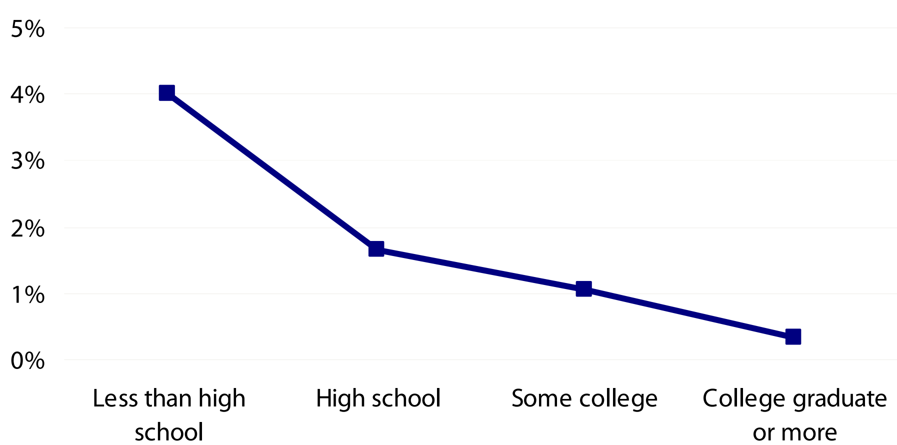


Crime

As people achieve higher education levels, they are statistically less likely to commit crimes. The analysis identifies the following three types of crime-related expenses: 1) incarceration, including prosecution, imprisonment, and reform, 2) victim costs, and 3) productivity lost as a result of time spent in jail or prison rather than working.

Figure 3 displays the probability that an individual will be incarcerated by education level. Data are derived from the breakdown of the inmate population by education level in state, federal, and local prisons (as provided by the Bureau of Justice Statistics), divided by the total population. As indicated, incarceration drops on a sliding scale as education levels rise.

Figure 3: Incarceration rates by education level



Victim costs comprise material, medical, physical, and emotional losses suffered by crime victims. Some of these costs are hidden, while others are available in various databases. Estimates of victim costs vary widely, attributable to differences in how the costs are measured. The lower end of the scale includes only tangible out-of-pocket costs, while the higher end includes intangible costs such as future loss of productivity resulting from traumas, crimes not handled or prosecuted through the judicial system, and money spent on personal security that would otherwise have been spent on other, more productive endeavors.[32]

Yet another measurable benefit is the added economic productivity of people who are now gainfully employed, all else being equal, and not incarcerated. The measurable productivity benefit here is simply the number of additional people employed multiplied by the average income in their corresponding education levels.

Welfare and Unemployment

Statistics show that as education levels increase, the number of welfare and unemployment applicants declines. Welfare recipients can receive assistance from a variety of different sources, including TANF (Temporary Assistance for Needy Families), food stamps, Medicaid, Supplemental Security Income (SSI), housing subsidies, child care services, weatherization programs, and various educational programs.

Figure 4 relates the probabilities that an individual will apply for welfare by education level, derived from data supplied by the Department of Health and Human Services. As shown, the probability of claiming welfare drops significantly as individuals move to higher levels of education. Note that these data are based on TANF recipients only, as these constitute the most needy welfare recipients and are the point of departure for the allocation between the other ethnic groups in the model.

Unemployment rates also decline with increasing levels of education, as illustrated in Figure 5. These data are supplied by the Bureau of Labor Statistics. As shown, unemployment rates range from 9% for those with less than a high school diploma to 2% for those at the doctoral degree level.

[32] The model makes use of tangible, lower end costs that can be directly measured without controversy. Thus, 2.0 million inmates (in 1999) divided into $105 billion costs an average of roughly $52,000 per inmate. From this we derive an estimate of $85,000, assuming that the 1999 study was based on at least two- to three-year-old data.

Figure 4: Probability of claiming welfare, by education level

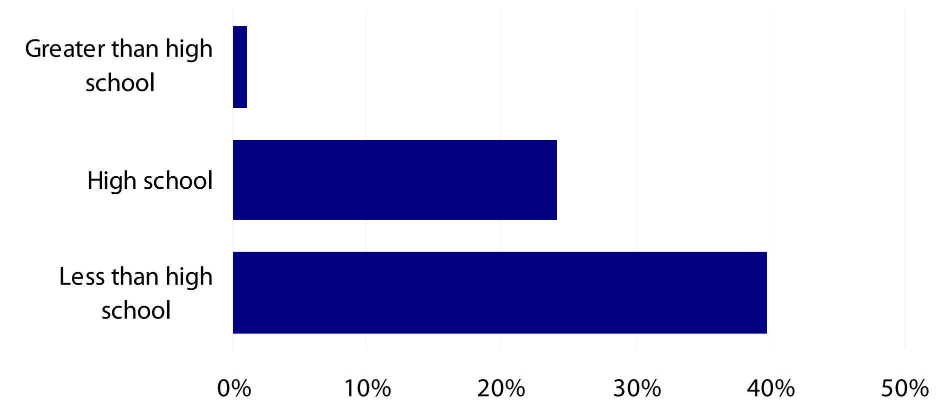
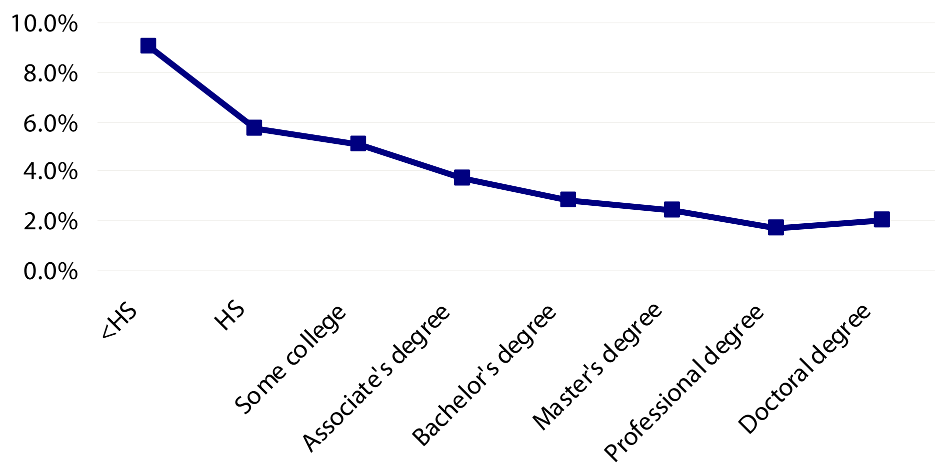


Figure 5: Unemployment rates by education level



Conclusion

The statistical databases bear out the simple correlation between education and improved health, lower incarceration rates, and reduced welfare and unemployment. These by no means comprise the full range of benefits one possibly can link to education. Other social benefits certainly may be identified in the future as reliable statistical sources are published and data are incorporated into the analytical framework. However, the fact that these incidental benefits occur and can be measured is a bonus that enhances the economic attractiveness of college operations.

Appendix 6: Investment Analysis – a Primer

The purpose of this appendix is to provide some context and meaning to the investment analysis results in general, using the simple hypothetical example summarized in Table 1 below. The table shows the projected (assumed) benefits and costs over time for one student and associated investment analysis results.[33]

Table 1. Costs and benefits

Year	Tuition	Opportunity cost	Total cost	Higher earnings	Net cash flow
1	2	3	4	5	6
1	$1,500	$20,000	$21,500	$0	-$21,500
2	$0	$0	$0	$5,000	$5,000
3	$0	$0	$0	$5,000	$5,000
4	$0	$0	$0	$5,000	$5,000
5	$0	$0	$0	$5,000	$5,000
6	$0	$0	$0	$5,000	$5,000
7	$0	$0	$0	$5,000	$5,000
8	$0	$0	$0	$5,000	$5,000
9	$0	$0	$0	$5,000	$5,000
10	$0	$0	$0	$5,000	$5,000
Net present value			**$20,680**	**$35,753**	**$15,080**
Internal rate of return					**18%**
Benefit/cost ratio					**1.7**
Payback period					**4.2 years**

Assumptions are as follows:

1. The time horizon is 10 years—*i.e.*, benefits and costs are projected out 10 years into the future (Column 1). Once education has been earned, benefits of higher earnings remain with the student into the future. The objective is to measure these future benefits and compare them to the costs of education.

[33] Note that this is a hypothetical example. The numbers used are not based on data collected from an existing college.

2. The student attends the college for one year, for which he or she pays total fees of $1,500 (Column 2).
3. The opportunity cost of time (earnings forgone while attending the college for one year) for this student is estimated at $20,000 (Column 3).
4. Together, these two cost elements ($21,500 total) represent the out-of-pocket investment made by the student (Column 4).
5. In return, it is assumed that the student, having completed the one year of study, will earn $5,000 more per year than he/she would have without the education (Column 5).
6. Finally, the net cash flow column (NCF) in Column 6 shows higher earnings (Column 5) less the total cost (Column 4).
7. The assumed "going rate" of interest is 4%, the rate of return from alternative investment schemes, for the use of the $21,500.

Results are expressed in standard investment analysis terms, which are as follows: the net present value (NPV), the internal rate of return (IRR, or simply RR), the benefit/cost ratio (B/C), and the payback period. Each of these is briefly explained below in the context of the cash flow numbers in Table 1.

Net present value (NPV)

"A bird in hand is worth two in the bush." This simple folk wisdom lies at the heart of any economic analysis of investments lasting more than one year. The student in Table 1 can choose either to attend the college or to forgo post-secondary education and maintain present employment. If he or she decides to enroll, certain economic implications unfold: student tuition and fees must be paid, and earnings will cease for one year. In exchange, the student calculates that with post-secondary education, his or her income will increase by at least the $5,000 per year as indicated in the table.

The question is simple—will the prospective student be economically better off by choosing to enroll? If he/she adds up higher earnings of $5,000 per year for the remaining nine years in Table 1, the total will be $45,000. Compared to a total investment of $21,500, this appears to be a very solid investment. The reality, however, is different—benefits are far lower than $45,000 because future money is worth less than present money. Costs (student tuition and fees plus forgone earnings) are felt immediately because they are incurred today—in the present. Benefits (higher earnings), on the other hand, occur in the future. They are not yet available. All future benefits must be discounted by the going rate of interest (referred to as the discount rate) to be able to express them in present value terms.[34] Let us take a brief example—at 4%, the present value of $5,000 to be received one year from today is $4,807. If the $5,000 were to be received in year ten, the present value would reduce to $3,377. Put another way, $4,807 deposited in the bank today earning 4% interest will grow to $5,000 in one year; and $3,377 deposited today would grow to $5,000 in ten years. An "economically rational" person would, therefore, be equally satisfied receiving $3,377 today or $5,000 ten years from today given the going rate of interest of 4%. The process of discounting—finding the present value of future higher earnings—allows the model to express values on an equal basis in future or present value terms.

The goal is to express all future higher earnings in present value terms so that they can be compared to investments incurred today—student tuition and fees and forgone earnings. As indicated in Table 1, the cumulative present value of $5,000 worth of higher earnings between years 2 and 10 is $35,747 given the 4% interest rate, far lower than the undiscounted $45,000 discussed above.

The net present value of the investment is $14,247. This is simply the present value of the benefits less the present value of the costs, or $35,747 − $21,500 = $14,247. In other words, the present value of benefits exceeds the present value of costs by as much as $14,247. The criterion for an economically worthwhile investment is that the net present value is equal to or greater than zero. Given this result, it can be concluded that, in this case, and given these assumptions, this particular investment in education is very strong.

Internal rate of return (IRR)

The internal rate of return is another way of measuring the worth of investing in education using the same cash flows shown in Table 1. In technical terms—the internal rate of return is a measure of the average earning power of money used over the life of the investment. It is simply the interest rate that makes the net present value equal to zero. In the NPV example above, the model applies the "going rate" of interest of 4% and computes a positive net present value of $14,247. The question now is what the interest rate would have to be in order to reduce the net present value to zero. Obviously it would have to be higher—18.0% in fact, as indicated in Table 1. Or, if a discount rate of 18.0% were applied to the NPV calculations instead of the 4%, then the net present value would reduce to zero.

[34] Technically, the interest rate is applied to compounding—the process of looking at deposits today and determining how much they will be worth in the future. The same interest rate is called a discount rate when the process is reversed—determining the present value of future earnings.

What does this mean? The internal rate of return of 18.0% defines a breakeven solution—the point where the present value of benefits just equals the present value of costs, or where the net present value equals zero. Or, at 18.0%, higher incomes of $5,000 per year for the next nine years will earn back all investments of $21,500 made plus pay 18.0% for the use of that money ($21,500) in the meantime. Is this a good return? Indeed it is. If it is compared to the 4% "going rate" of interest applied to the net present value calculations, 18.0% is far higher than 4%. It may be concluded, therefore, that the investment in this case is solid. Alternatively, comparing the 18.0% rate of return to the long-term 7% rate or so obtained from investments in stocks and bonds also indicates that the investment in education is strong relative to the stock market returns (on average).

A word of caution—the IRR approach can sometimes generate "wild" or "unbelievable" results—percentages that defy the imagination. Technically, the approach requires at least one negative cash flow (student tuition and fees plus opportunity cost of time) to offset all subsequent positive flows. For example, if the student works full-time while attending the college, the opportunity cost of time would be much lower; the only out-of-pocket cost would be the $1,500 paid for student tuition and fees. In this case, it is still possible to compute the internal rate of return, but it would be a staggering 333% because only a negative $1,500 cash flow will be offsetting nine subsequent years of $5,000 worth of higher earnings. The 333% return is technically correct, but not consistent with conventional understanding of returns expressed as percentages. For purposes of this report, therefore, all results exceeding 100% are expressed simply as: "n/a" or ">100%."

Benefit/cost ratio (B/C)

The benefit/cost ratio is simply the present value of benefits divided by present value of costs, or $35,747 ÷ $21,500 = 1.7 (based on the 4% discount rate). Of course, any change in the discount rate will also change the benefit/cost ratio. Applying the 18.0% internal rate of return discussed above would reduce the benefit/cost ratio to 1.0—or the breakeven solution where benefits just equal costs. Applying a discount rate higher than the 18.0% would reduce the ratio to lower than 1.0, and the investment would not be feasible. The 1.7 ratio means that a dollar invested today will return a cumulative $1.70 over the ten-year time period.

Payback period

This is the length of time from the beginning of the investment (consisting of student tuition and fees plus earnings forgone) until higher future earnings give a return on the investments made. For the student in Table 1, it will take roughly 4.2 years of $5,000 worth of higher earnings to recapture his or her investment of $1,500 in student tuition and fees and the $20,000 earnings he or she forgoes while attending the college. Higher earnings occurring beyond 4.2 years are the returns that make the investment in education in this example economically worthwhile. The payback period is a fairly rough, albeit common, means of choosing between investments. The shorter the payback period, the stronger the investment.

Appendix 7: Alternative Education Variable

Introduction

The alternative education variable is the percent of students who would still be able to avail themselves of education absent the publicly funded colleges and universities in the state. This variable is estimated in the model through a regression analysis based on data supplied by 117 two-year community and technical colleges previously analyzed by EMSI. The purpose of this appendix is to lay out the theoretical framework for determining the alternative education opportunity variable and the data used to make this determination.

Alternative education variable in function form

The alternative education variable is the dependent variable, expressed in functional form as follows:

1) $Y = b_1X_1 + b_2X_2 + b_3X_3 + e$

Where:

Y = Dependent variable

b_i = partial regression coefficients

e = standard error

Independent variables

The three independent variables reflect the explanatory parameters that form the theoretical backdrop to the internal estimation of the dependent variable based on 117 observations. The three independent variables include the following:

X_1 = Population per square mile in the service region

This variable defines the population density of the service region. A positive coefficient (b) is expected; *i.e.*, the more densely populated the area, the more numerous the alternative education opportunities will be.[35]

X_2 = Number of private school employees per 1,000 population per square mile in the service region

[35] Available from U.S. Census Bureau, Current Population Survey.

This variable is a proxy for the availability of private educational institutions providing alternative education opportunities in the region. A positive coefficient (b) is expected; *i.e.,* the more private school employees, the more alternative education opportunities there are in the area.[36]

X_3 = Personal income

The average personal income of residents in the region serves as a measure of the relative economic well-being of the area. A positive coefficient (b) is expected; *i.e.,* the higher the average earnings in the area, the more the students will be able to avail themselves of the alternative education opportunities. This number is expressed in thousands.[37]

Example of analysis and results

The procedure used to estimate the parameters was the ordinary least squares procedure (OLS). Fitting the equation by OLS yielded the following results:

2) $$Y = 3.43E - 05X_1 + 0.023565X_2 + 0.005748X_3 + 0.064722$$

$$(2.723) \quad (1.4765) \quad (3.1326)$$

R^2 = .458 (coefficient of determination)

F = 31.84 (Fischer test statistic)

The numbers in parentheses below the coefficients are the "t" values (all statistically significant). The R^2 measures the degree to which the independent variables explain the variation in the dependent variable. The maximum R^2 attainable (1.00) is the case in which all observations fall on the regression line and all variability is explained. The .458 R^2 obtained in equation (2) indicates that nearly 46 percent of the variation in the alternative education opportunity is explained by the variables. The F-ratio indicates that the equation can be considered a good predictor of the alternative education opportunity.

The positive signs of the regression coefficients agree with expected relationships. As population density, the number of private school employees, and personal income increase, so does the provision of alternative education opportunities.

For example, suppose the college has a service region of five counties. The total population of the five counties is 188,341, while the size of the region is 3754 square miles; the average population per square mile is therefore a little over 50. Within this region, there is one higher education private school employee for every 3,000

[36] Available from U.S. Department of Commerce, County Business Patterns.

[37] Available from U.S. Department of Commerce, Bureau of Economic Analysis, REIS Employment and Earnings Reports.

residents. Finally, the average income per person within the region is $21,869 per year. Using these data, the following results are produced:

3) $Y = (3.43E - 05 \times 50.2) + (0.023565 \times .3318) + (0.005748 \times 21.869)$

4) $Y = 13.5\%$

Thus, according to these calculations, an estimated 13.5% of the student population would have been able to receive an education elsewhere if there were no publicly funded colleges and universities in the state.