The Economic Value of American Indian and Alaska Native Tribal Colleges & Universities

An Analysis of the Economic Impact and Return on Investment of Education

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Executive Summary

This report assesses the collective economic benefits of the Tribal Colleges and Universities (TCUs) on the national economy and the benefits generated by the TCUs for students, tribes, society, and taxpayers. For the purposes of this report, TCUs include 34[1] institutions. The results of this study show that TCUs create a positive net impact on the national economy and generate a positive investment for students, tribes, society, and taxpayers.

Economic impact on the national business community

Approximately **100 percent** of TCU students stay in the U.S. after exiting one of the TCUs. Their enhanced skills and abilities bolster the output of employers, leading to higher income and a more robust economy. The accumulated contribution of former TCU students who were employed in the national workforce in AY 2013-14 amounted to **$2.3 billion** in added income in the U.S. economy.

The total impact of TCUs on the national business community in the U.S. in AY 2013-14 was approximately equal to creating **28,778** jobs.[2]

Investment analysis

Investment analysis compares the costs and benefits of an investment to determine whether or not it is profitable. This study considers TCUs as an investment from the perspectives of students, tribes, society, and taxpayers.

Student perspective

Students invest their own money and time in their education. Students enrolled at TCUs paid an estimated total of **$38.8 million** to cover the cost of tuition, fees, books, and supplies at the TCUs in AY 2013-14. While some students were employed while attending the TCUs, overall students forwent an estimated **$155.3** million in earnings that they would have generated had they been in full employment instead of learning. In return, students will receive a present value of **$794.3 million** in increased earnings over their working lives. This translates to a return of **$4.10** in higher future income for every $1 that students pay for their education at TCUs. The corresponding annual rate of return is **16.6 percent**.

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[1] AIHEC has a membership of 37 TCUs, but 34 TCUs are included within this analysis. See Appendix 1 for a list of involved TCUs.

[2] This figure is undoubtedly higher, but most TCUs have only recently begun to track student/graduate employment. Some TCUs do not yet track this data.

Societal perspective

The U.S. as a whole spent an estimated **$572.5 million** on educations at TCUs in AY 2013-14. This includes **$406.8 million** in expenses by TCUs, **$10.3 million** in student expenses, and **$155.3** million in student opportunity costs. In return, the U.S. will receive an estimated present value of **$2.7 billion** in added national income over the course of the students' working lives. The U.S. will also benefit from an estimated **$196.6 million** in present value social savings related to reduced crime, lower welfare and unemployment, and increased health and well-being across the nation. For every dollar society invests in an education from TCUs, an average of **$5.20** in benefits will accrue to the U.S. over the course of the students' careers. The benefits TCUs provide in enriching society by preserving tribal languages, cultures, traditions, lands, and sovereignty cannot be measured in economic terms. These are, indeed, priceless.

Taxpayer perspective

Taxpayers provided **$337.9 million** of government funding to TCUs in AY 2013-14. In return, taxpayers will receive an estimated present value of **$715.1 million** in added tax revenue stemming from the students' higher lifetime incomes and the increased output of businesses. Savings to the public sector add another estimated **$46 million** in benefits due to a reduced demand for government-funded social services in the U.S. For every tax dollar spent on educating students attending TCUs, taxpayers will receive an average of **$2.40** in return over the course of the students' working lives. In other words, taxpayers enjoy an annual rate of return of **6.2 percent**.

Introduction

The American Indian Higher Education Consortium (AIHEC), comprised of 37 Tribal Colleges and Universities (TCUs), creates value in many ways.[3] With a wide range of program offerings, the TCUs play a key role in helping students achieve their individual potential and develop the skills they need in order to have a fulfilling and prosperous career. The TCUs also provide an excellent environment for students to meet new people, while participation in college courses improves the students' self-confidence and promotes their mental health. These social and employment-related benefits have a positive influence on the health and well-being of individuals.

However, the contribution of TCUs consists of more than solely influencing the lives of students. The program offerings support a range of industry sectors in the U.S. and supply employers with the skilled workers they need to make their businesses more productive. Lastly, and just as importantly, the economic impact of TCUs extends as far as the national treasury in terms of increased tax receipts and decreased public sector costs. Of course, the contributions of TCUs to individuals, tribes, and the nation as a whole through preservation of tribal languages, cultures, traditions, lands, and sovereignty cannot be adequately measured in economic terms. These are, indeed, priceless.

Objective of the report

This report assesses the impact of TCUs on the national business community and the return on investment for the TCUs' key stakeholder groups: students, tribes, society, and taxpayers. Our approach is twofold. We begin with an economic impact analysis of TCUs on the national business community in the U.S. To derive results, we rely on a specialized Social Accounting Matrix (SAM) model to calculate the additional income created in the U.S. economy as a result of the added skills of known students and the associated increase in consumer spending. Results of the national economic impact analysis are summarized according to the impact of the skills acquired by former students that are still active in the U.S. workforce.

The second component of the study is a standard investment analysis to determine how money spent on TCUs performs as an investment over time. The investors in this case are students, tribes, society, and taxpayers, all of whom pay a certain amount in costs to support the educational activities at TCUs. The students' investment consists of their out-of-pocket expenses and the opportunity cost of attending college as opposed to working. Society invests in education by forgoing the services that it would have received had government not funded TCUs and the business output that it would have enjoyed had students been employed instead of studying. Taxpayers contribute their investment through government funding.

[3] AIHEC has a membership of 37 TCUs, but 34 TCUs are included within this analysis. See Appendix 1 for a list of involved TCUs.

In return for these investments, students receive a lifetime of higher incomes, tribes and all of society benefit from an enlarged economy and a reduced demand for social services, and taxpayers benefit from an expanded tax base and a collection of public sector savings. To determine the feasibility of the investment, the model projects benefits into the future, discounts them back to their present value, and compares them to their present value costs. Results of the investment analysis for students, tribes, society, and taxpayers are displayed in the following four ways: 1) net present value of benefits, 2) rate of return, 3) benefit-cost ratio, and 4) payback period.

A wide array of data and assumptions are used in the study based on several sources, including the 2013-14 academic and financial reports from the TCUs, industry and employment data from the U.S. Bureau of Labor Statistics and U.S. Census Bureau, outputs of EMSI's SAM model, and a variety of published materials relating education to social behavior. The study aims to apply a conservative methodology and follows standard practice using only the most recognized indicators of investment effectiveness and economic impact.

Important Notes

There are three notes of importance that readers should bear in mind when reviewing the findings presented in this report. First, this report is not intended to be a vehicle for comparing TCUs with other publicly funded institutions. Other studies comparing the gains in income and social benefits of one institution relative to another address such questions more directly and in greater detail. Our intent is simply to provide management teams and stakeholders of TCUs with pertinent information should questions arise about the extent to which the TCUs impact the national economy and generate a return on investment. Differences between TCUs' results and those of other institutions, however, do not necessarily indicate that one institution is doing a better job than another. 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 institutions. For this reason, comparing results between institutions or using the data to rank institutions is strongly discouraged.

Second, this report is useful in establishing a benchmark for future analysis, but it is limited in its ability to put forward recommendations on what TCUs can do next. The implied assumption is that the TCUs can effectively improve their results if they increase the number of students they serve, help students to achieve their educational goals, and remain responsive to employer needs in order to ensure that students find meaningful jobs after exiting. Establishing a strategic plan for achieving these goals, however, is not the purpose of this report.

Finally, the benefits TCUs provide in enriching society by preserving tribal languages, cultures, traditions, lands, and sovereignty cannot be measured in economic terms. These are, indeed, priceless.

Chapter 1: Profile of TCUs and the National Economy

1.1 About AIHEC and the Tribal Colleges and Universities

The American Indian Higher Education Consortium (AIHEC) represents a diverse array of Tribal Colleges and Universities (TCUs) across the country that are united by their common purpose: to provide quality post-secondary education that both serves and is governed by American Indian/Alaska Native tribes. While the services they offer are available to anyone, their primary purpose is to meet the unique needs of America's many Indian nations.

Since the first tribal colleges came together to establish AIHEC in 1973, AIHEC has advocated on their behalf at the federal level. AIHEC also assists the tribal colleges reflect the unique cultural and economic needs of Indian nations. From the beginning, TCUs have provided a unique education founded on the culture of the various Nations involved and to support the communities in which they are located. When AIHEC was established, it included a total of six colleges. As of 2015, AIHEC is composed of 37 institutions in 16 states. For a complete list of member institutions, see Appendix 1.

While all the TCUs are fairly small in size, AIHEC's member institutions vary significantly in enrollment. For example, White Earth Tribal and Community College, which is located in the small town of Mahnomen, Minnesota (pop. 1,214), and is operated by the the White Earth Nation, served 119 students in the 2013-14 school year. At the other end of the spectrum, Northwest Indian College, in Bellingham, Washington, which is operated by the Lummi Nation, enrolled 2,719 students in the same year. Of the TCUs, 11 had enrollments of under 500 students, while 22 were under 1,000.[4]

The small size of many TCU student bodies reflects a unique and important aspect of their contribution to their regions. TCUs frequently serve small and isolated communities in out-of-the-way areas – communities and populations that would otherwise have, at best, extremely limited access to post-secondary education. Beyond simply providing economic benefit, the TCUs thereby help tribal populations maintain their strength and sovereignty while staying culturally and economically relevant.

[4] Enrollments reflect annual unduplicated headcounts.

Figure 1

As part of this mission, TCUs offer a variety of unique and interesting programs relevant other specific needs of their communities. Most TCUs offer classes related to the history and culture of the Indian communities they serve. For example, Ilisagvik College in northern Alaska, which serves the Iñupiaq (Eskimo) tribe, offers an associate of arts degree in Iñupiaq studies, in which students learn to fluently speak the Iñupiaq language and to appreciate and work in the Iñupiaq artistic tradition in order to understand their own heritage.

Similarly, Aaniii Nakoda College, in Harlem, Montana, is working to preserve the Aaniiih and Nakoda languages and their associated traditions. With the assistance of funding from the Institute of Museum and Library Services, the college has worked to record and transcribe the language so that it can be preserved and studied in the future. This has included a two-year project to translate a number of childrens' books into Aaniiih and Nakoda, so that it's possible for children in the two tribes to grow up familiar with their native language and history.

1.2 Employee and finance data

Estimating the benefits and costs of TCUs requires three types of information: 1) employee and finance data, 2) student demographic and achievement data, and 3) the economic profile of the nation. For the purpose of this study, information on the TCUs and their students was obtained from TCUs, and data on the national economy were drawn from EMSI's proprietary data modeling tools.

1.2.1 Employee data

Data provided by TCUs include information on their full-time and part-time faculty and staff. These data appear in Table 1.1. As shown, TCUs employed 3,390 full-time and 1,683 part-time faculty and staff in AY 2013-14.

Table 1.1: Employee data, AY 2013-14

Full-time faculty and staff (headcount)	3,390
Part-time faculty and staff (headcount)	1,683
Total faculty and staff	**5,073**

Source: Data supplied by TCUs.

1.2.2 Revenues

Table 1.2 shows annual revenues of TCUs by funding source – a total of $485.1 million in AY 2013-14. As indicated, tuition and fees comprised 6 percent of total revenue, government revenue another 70 percent, and all other revenue (i.e., auxiliary revenue, sales and services, interest, and donations) the remaining 24 percent. These data are critical in identifying the annual costs of educating the student body from the perspectives of students and taxpayers.

Table 1.2: TCUs revenue by source, AY 2013-14

Funding source	Total	% of total
Tuition and fees	$28,491,063	6%
Local government revenue	$29,063,117	6%
State government revenue	$13,656,271	3%
Federal government revenue	$295,141,063	61%
All other revenue	$118,701,514	24%
Total revenues	**$485,053,028**	**100%**

Source: Data supplied by TCUs.

1.2.3 Expenditures

TCUs' combined payroll amounted to $193.9 million, equal to 48 percent of their total expenses for AY 2013-14. Other expenditures, including capital and purchases of supplies and services, made up $212.9 million. These budget data appear in Table 1.3.

Table 1.3: TCUs expenses by function, AY 2013-14

Expense item	Total	%
Employee payroll	$193,949,722	48%
Capital depreciation	$25,420,168	6%
All other expenditures	$187,479,670	46%
Total expenses	**$406,849,560**	**100%**

Source: Data supplied by TCUs.

1.3. Student profile data

1.3.1 Demographics

TCUs served 22,797 credit students and 8,697 non-credit students in the 2013-14 reporting year (unduplicated). The breakdown of the student body by gender was 37 percent male, 63 percent female, and the breakdown by ethnicity was 88 percent minorities, 10 percent whites, and 2 percent unknown. The students' overall average age was 30 years old. An estimated 100 percent remained in the U.S. after finishing their time at the TCUs.

1.3.2 Achievements

Table 1.4 summarizes the breakdown of the student population and their corresponding achievements by education level. Achievements are measured in terms of credit hour equivalents (CHEs), which are equal in value to one credit (or 15 contact hours) of classroom instruction. The educational level and CHE production of students of TCUs are key to determining how far students advance in their education during the course of the reporting year and the associated value of that achievement.

As indicated, TCUs served 14 master's degree graduates, 337 bachelor's degree graduates, 1,409 associate's degree graduates, and 592 certificate graduates in the 2013-14 reporting year. A total of 19,383 credit-bearing students pursued but did not complete a credential during the reporting year, while another 0 students prepared for transfer to a different institution. TCUs also served 1,062 dual credit students, 974 basic education students, and 4,623 personal enrichment students. Workforce and all other students comprised the remaining 3,100 students.

Table 1.4: Breakdown of student headcount and CHE production by education level, 2013-14

Category	Headcount	Total CHEs	Average CHEs
Master's degree graduates	14	128	9.1
Bachelor's degree graduates	337	8,378	24.9
Associate's degree graduates	1,409	31,412	22.3
Certificate graduates	592	13,863	23.4
Continuing students	19,383	272,346	14.1
Dual credit students	1,062	4,765	4.5
Basic education students	974	8,496	8.7
Personal enrichment students	4,623	12,540	2.7
Workforce and all other students	3,100	10,189	3.3
Total, all students	**31,494**	**362,116**	**11.5**
Total, less personal enrichment students	**26,871**	**349,576**	**13.0**

Source: Data supplied by TCUs.

Altogether, students from TCUs completed 349,576 credit hour equivalents (CHEs) during the 2013-14 reporting year. In the analysis, we exclude the CHE production of personal enrichment students under the assumption that they do not attain workforce skills that will increase their earnings. The average number of CHEs per student (excluding personal enrichment students) was 13.0.

1.4 National profile data

1.4.1 Gross Domestic Product

Since they were established, TCUs have served the U.S. by enhancing the workforce and providing tribal residents with easy access to quality higher education opportunities. Table 1.5 summarizes the breakdown of the U.S. 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 forms of investment income. Together, labor and non-labor income comprise the nation's total Gross Domestic Product (GDP).

As shown in Table 1.5, the nation's GDP is approximately $16.5 trillion, equal to the sum of labor income ($9756.3 billion) and non-labor income ($6757.2 billion). In Chapter 2, we use the GDP of the U.S. as the backdrop against which we measure the relative impacts of the TCUs on the national economy.

Table 1.5: Labor and non-labor income by major industry sector in the U.S., 2014

Industry sector	Labor income (millions)	Non-labor income (millions)	Total income (millions)	% of Total
Agriculture, Forestry, Fishing and Hunting	$100,949	$76,678	$177,627	1.1%
Mining	$134,870	$282,697	$417,567	2.5%
Utilities	$71,450	$202,961	$274,411	1.7%
Construction	$455,398	$172,104	$627,503	3.8%
Manufacturing	$949,388	$1,123,545	$2,072,933	12.6%
Wholesale Trade	$480,203	$475,188	$955,391	5.8%
Retail Trade	$567,862	$277,591	$845,454	5.1%
Transportation and Warehousing	$315,775	$150,581	$466,356	2.8%
Information	$304,226	$490,913	$795,139	4.8%
Finance and Insurance	$834,356	$447,526	$1,281,882	7.8%
Real Estate and Rental and Leasing	$290,614	$941,607	$1,232,221	7.5%
Professional and Technical Services	$929,326	$176,379	$1,105,706	6.7%
Management of Companies and Enterprises	$273,441	$50,810	$324,251	2.0%
Administrative and Waste Services	$398,512	$103,898	$502,410	3.0%
Educational Services	$177,232	$18,774	$196,006	1.2%
Health Care and Social Assistance	$1,057,133	$103,362	$1,160,495	7.0%
Arts, Entertainment, and Recreation	$117,342	$51,059	$168,401	1.0%
Accommodation and Food Services	$277,634	$142,126	$419,760	2.5%
Other Services (except Public Administration)	$266,671	$34,901	$301,572	1.8%
Public Administration	$1,643,504	$422,540	$2,066,044	12.5%
Other Non-industries	$110,443	$1,012,001	$1,122,444	6.8%
Total	**$9,756,329**	**$6,757,243**	**$16,513,572**	**100.0%**

* 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.

1.4.2 Jobs by industry

Table 1.6 provides the breakdown of jobs by industry in the U.S. Among the nation's non-government industry sectors, the "Health Care and Social Assistance" sector is the largest employer, supporting 20,497,040 jobs or 11.3 percent of total employment in the nation. The second largest employer is the "Retail Trade" sector, supporting 18,181,524 jobs or 10.0 percent of the nation's total employment. Altogether, the U.S. supports 181.7 million jobs.[5]

[5] Job numbers reflect EMSI's complete employment data, which includes the following four job classes: 1) employees that are counted in the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW), 2) employees that are not covered by the federal or state unemployment insurance (UI) system and are thus excluded from QCEW, 3) self-employed workers, and 4) extended proprietors.

Table 1.6: Jobs by major industry sector in the U.S., 2013

Industry sector	Total jobs	% of Total
Agriculture, Forestry, Fishing and Hunting	3,511,511	1.9%
Mining	1,625,670	0.9%
Utilities	573,893	0.3%
Construction	9,229,387	5.1%
Manufacturing	12,707,266	7.0%
Wholesale Trade	6,329,301	3.5%
Retail Trade	18,181,524	10.0%
Transportation and Warehousing	6,028,945	3.3%
Information	3,302,995	1.8%
Finance and Insurance	9,947,978	5.5%
Real Estate and Rental and Leasing	8,042,751	4.4%
Professional and Technical Services	12,470,165	6.9%
Management of Companies and Enterprises	2,267,896	1.2%
Administrative and Waste Services	11,293,919	6.2%
Educational Services	4,424,343	2.4%
Health Care and Social Assistance	20,497,040	11.3%
Arts, Entertainment, and Recreation	4,060,595	2.2%
Accommodation and Food Services	13,027,389	7.2%
Other Services (except Public Administration)	10,173,041	5.6%
Public Administration	24,012,379	13.2%
Total	**181,707,987**	**100.0%**

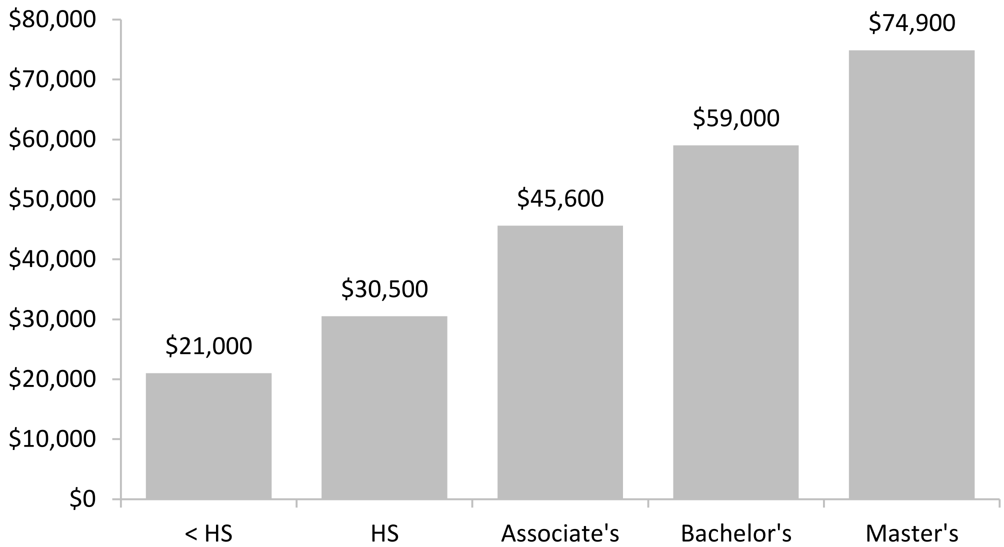
* Data reflect the most recent year for which data are available. EMSI data are updated quarterly.
† Numbers may not add due to rounding.
Source: EMSI complete employment data.

1.4.3 Earnings by education level

Figure 1.1 presents the mean income levels by education level in the U.S. at the midpoint of the average-aged worker's career. These numbers are derived from EMSI's complete employment data on average income per worker in the nation.[6] As shown, students who achieve an associate's degree can expect $41,700 in income per year, approximately $10,400 more than someone with a high school diploma. The difference between a high school diploma and the attainment of a bachelor's degree is even greater – up to $28,400 in higher income.

[6] Wage rates in the EMSI SAM model combine state and federal sources to provide earnings that reflect complete employment, including 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 1.1: Expected income by education level at career midpoint



1.5 Conclusion

This chapter presents the broader elements of the database used to determine the results of the study. 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 considers TCUs' impact on the national economy and Chapter 3 looks at TCUs as an investment. The appendices detail a collection of miscellaneous theory and data issues.

Chapter 2: Economic Impact Analysis

TCUs impact their local economies in a variety of ways, such as through their expenditures on payroll and operations and by attracting students to study at their institutions. At the national level, the TCUs serve as a primary source of higher education to tribal residents. TCUs supply trained workers to industry and contribute to associated increases in national output. In this chapter we track TCUs' national economic impact under the alumni impact, comprising the added income created in the U.S. as former students expand the economy's stock of human capital.

Economic impact analyses use different types of impacts to estimate the results. The impact focused on in this study is the **income impact**, which assesses the change in Gross Domestic Product (GDP.) Income may be further broken out into the **labor income impact**, which assesses the change in employee compensation; and the **non-labor income impact**, which assesses the change in income business profits. Another way to state the income impact is **jobs based on income**, a measure of the number of full- and part-time jobs that would be required to support the change in income. Finally, a frequently used measure is the sales impact, which comprises the change in business sales revenue in the economy as a result of increased economic activity. It is important to bear in mind, however, that much of this sales revenue leaves the economy and overstates actual impacts. All of these measures – jobs, income, and sales – are used to estimate the economic impact results presented in this section.

The analysis breaks out the impact measures into different components, each based on the economic effect that caused the impact. The following is a list of each type of effect presented in this analysis:

- The **initial effect** is the exogenous shock to the economy caused by the initial spending of money, whether to pay for salaries and wages, purchase goods or services, or cover operating expenses.
- The initial round of spending creates more spending in the economy, resulting in what is commonly known as the **multiplier effect**. The multiplier effect comprises the additional activity that occurs across all industries in the economy and may be further decomposed into the following three types of effects:
    - The **direct effect** refers to the additional economic activity that occurs as the industries affected by the initial effect spend money to purchase goods and services from their supply chain industries.
    - The **indirect effect** occurs as the supply chain of the initial industries creates even more activity in the economy through their own inter-industry spending.

The terminology used to describe the economic effects listed above differs slightly from that of other commonly used input-output models, such as IMPLAN. For example, the initial effect in this study is called the "direct effect" by IMPLAN, as shown in the table below. Further, the term "indirect effect" as used by IMPLAN refers to the combined direct and indirect effects defined in this study. To avoid confusion, readers are encouraged to interpret the results presented in this section in the context of the terms and definitions listed above. Note that, regardless of the effects used to decompose the results, the total impact measures are analogous.

EMSI	Initial	Direct	Indirect
IMPLAN	Direct	Indirect	

Multiplier effects in this analysis are derived using EMSI's Social Accounting Matrix (SAM) input-output model that captures the interconnection of industries, government, and households in the nation. The EMSI SAM contains approximately 1,100 industry sectors at the highest level of detail available in the North American Industry Classification System (NAICS) and supplies the industry-specific multipliers required to determine the impacts associated with increased activity within a given economy. For more information on the EMSI SAM model and its data sources, see Appendix 3.

2.1 Alumni impact

In this section we estimate the economic impacts stemming from the higher labor income of alumni in combination with their employers' higher non-labor income. Former students who achieved a degree as well as those who may not have finished their degree or did not take courses for credit are considered alumni.

The greatest economic impact of TCUs stems from the added human capital – the knowledge, creativity, imagination, and entrepreneurship – found in their alumni. While attending TCUs, students receive experience, education, and the knowledge, skills, and abilities that increase their productivity and allow them to command a higher wage once they enter the workforce. But the reward of increased productivity does not stop there. Talented professionals make capital more productive too (e.g., buildings, production facilities, equipment). The employers of alumni from TCUs enjoy the fruits of this increased productivity in the form of additional non-labor income (i.e., higher profits).

The alumni impact is the result of years of past instruction and the associated accumulation of human capital. The initial effect of alumni is comprised of two main components. The first and largest is the added labor income of former students from the TCUs. The second component of the initial effect includes the added non-labor income of the businesses that employ former students of TCUs.

We begin by estimating the portion of alumni who are employed in the workforce. To estimate the historical employment patterns of alumni in the nation, we use the following sets of data or assumptions: 1) settling-in factors to determine how long it takes the average student to settle into a career;[7] 2) death, retirement, and unemployment rates from the National Center for Health Statistics, the Social Security Administration, and the Bureau of Labor Statistics; and 3) migration data from the

[7] Settling-in factors are used to delay the onset of the benefits to students in order to allow time for them to find employment and settle into their careers. In the absence of hard data, we assume a range between one and three years for students who graduate with a certificate or a degree, and between one and five years for returning students.

U.S. Census Bureau. The result is the estimated portion of alumni from each previous year who were still actively employed in the nation as of AY 2013-14.

The next step is to quantify the skills and human capital that alumni acquired from the TCUs. We use the students' production of credit hour equivalents (CHEs) as a proxy for accumulated human capital. The average number of CHEs completed per student in 2013-14 was 13.0. To estimate the number of CHEs present in the workforce during the analysis year, we use historical student headcount over the past 30 years, from 1984-85 to 2013-14, from the TCUs.[8] We multiply the 13.0 average CHEs per student by the headcounts that we estimate are still actively employed from each of the previous years.[9] Students who enroll at the TCUs more than one year were counted at least twice in the historical enrollment data. However, CHEs remain distinct regardless of when and by whom they were earned, so there is no duplication in the CHE counts. We estimate there are approximately 7.5 million CHEs from alumni active in the workforce.

Next, we estimate the value of the CHEs or the skills and human capital acquired by alumni of TCUs. This is done using the *incremental* added labor income stemming from the students' higher wages. The incremental labor income is the difference between the wage earned by alumni of TCUs and the alternative wage they would have earned had they not attended one of the TCUs. Using the incremental earnings, credits required, and distribution of credits at each level of study, we estimate the average value per CHE to equal $168. This value represents the average incremental increase in wages that alumni of TCUs received during the analysis year for every CHE they completed.

Because workforce experience leads to increased productivity and higher wages, the value per CHE varies depending on the students' workforce experience, with the highest value applied to the CHEs of students who had been employed the longest by AY 2013-14, and the lowest value per CHE applied to students who were just entering the workforce. More information on the theory and calculations behind the value per CHE appears in Appendix 4. In determining the amount of added labor income attributable to alumni, we multiply the CHEs of former students in each year of the historical time horizon by the corresponding average value per CHE for that year, and then sum the products together. This calculation yields approximately $1.3 billion in gross labor income in increased wages received by former students in AY 2013-14 (as shown in Table 2.1).

[8] We apply a 30-year time horizon because the data on students who attended TCUs prior to 1984-85 is less reliable, and because most of the students served more than 30 years ago had left the regional workforce by 2013-14.

[9] This assumes the average credit load and level of study from past years is equal to the credit load and level of study of students today.

Table 2.1: Number of CHEs in workforce and initial labor income created in the U.S.

Number of CHEs in workforce	7,518,178
Average value per CHE	$168
Initial labor income, gross	**$1,263,872,180**
Percent reduction for alternative education opportunities	15%
Initial labor income, net	**$1,074,291,353**

Source: EMSI impact model.

The next row in Table 2.1 shows an adjustment used to account for counterfactual outcomes. As discussed above, counterfactual outcomes in economic analysis represent what would have happened if a given event had not occurred. The event in question is the education and training provided by TCUs. The counterfactual scenario that we address is the adjustment for alternative education opportunities. In the counterfactual scenario where TCUs do not exist, we assume a small portion of their alumni would have received an education elsewhere in the nation. The incremental labor income that accrues to those students cannot be counted towards the added labor income from alumni of TCUs. The adjustment for alternative education opportunities amounts to a 15 percent reduction of the $1.3 billion in added labor income.[10] This means that 15 percent of the added labor income from alumni who attended TCUs would have been generated in the U.S. anyway, even if the TCUs did not exist. For more information on the alternative education adjustment, see Appendix 5.

The $1.1 billion in added labor income appears under the initial effect in the labor income column of Table 2.2. To this we add an estimate for initial non-labor income. As discussed earlier in this section, businesses that employ former students of TCUs see higher profits as a result of the increased productivity of their capital assets. To estimate this additional income, we allocate the initial increase in labor income ($1.1 billion) to the six-digit NAICS industry sectors where students are most likely to be employed. This allocation entails a process that maps completers in the nation to the detailed occupations for which those completers have been trained, and then maps the detailed occupations to the six-digit industry sectors in the SAM model.[11] Using a crosswalk created by National Center for Education Statistics (NCES) and the Bureau of Labor Statistics (BLS), we map the breakdown of national completers to the approximately 700 detailed occupations in the Standard Occupational Classification (SOC) system. Finally, we apply a matrix of wages by industry and by occupation from the SAM model to map the occupational distribution of the $1.1 billion in initial labor income effects to the detailed industry sectors in the SAM model.[12]

[10] For a sensitivity analysis of the alternative education opportunities variable, see Section 4.

[11] Completer data comes from the Integrated Postsecondary Education Data System (IPEDS), which organizes program completions according to the Classification of Instructional Programs (CIP) developed by the National Center for Education Statistics (NCES).

[12] For example, if the SAM model indicates that 20% of wages paid to workers in SOC 51-4121 (Welders) occur in NAICS 332313 (Plate Work Manufacturing), then we allocate 20% of the initial labor income effect under SOC 51-4121 to NAICS 332313.

Once these allocations are complete, we apply the ratio of non-labor to labor income provided by the SAM model for each sector to our estimate of initial labor income. This computation yields an estimated $507.5 million in non-labor income attributable to alumni of TCUs. Summing initial labor and non-labor income together provides the total initial effect of alumni productivity in the U.S. economy, equal to approximately $1.6 billion. To estimate multiplier effects, we convert the industry-specific income figures generated through the initial effect to sales using sales-to-income ratios from the SAM model. We then run the values through the SAM's multiplier matrix.

Table 2.2: Alumni impact

	Labor income (thousands)	Non-labor income (thousands)	Value added (thousands)	Sales	Jobs
Initial effect	**$1,074,291**	**$507,526**	**$1,581,817**	**$3,048,883**	**19,507**
Multiplier effect					
Direct effect	$300,189	$167,650	$467,839	$898,961	5,661
Indirect effect	$192,999	$105,874	$298,874	$582,293	3,611
Total multiplier effect	**$493,188**	**$273,525**	**$766,713**	**$1,481,254**	**9,272**
Total impact (initial + multiplier)	**$1,567,479**	**$781,051**	**$2,348,530**	**$4,530,137**	**28,778**

Source: EMSI impact model.

Table 2.2 shows the multiplier effects of alumni. Multiplier effects occur as alumni generate an increased demand for consumer goods and services through the expenditure of their higher wages. Further, as the industries where alumni are employed increase their output, there is a corresponding increase in the demand for input from the industries in the employers' supply chain. Together, the incomes generated by the expansions in business input purchases and household spending constitute the multiplier effect of the increased productivity of TCU alumni.

The final results are $493.2 million in labor income and $273.5 million in non-labor income, for an overall total of $766.7 million in multiplier effects. The grand total of the alumni impact thus comes to $2.3 billion in value added, the sum of all initial and multiplier labor and non-labor income effects. This is equivalent to 28,778 jobs.

Chapter 3: Investment Analysis

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 TCUs as an investment from the perspectives of students, tribes, society, and taxpayers. The backdrop for the investment analysis for society and taxpayers is the entire U.S.

3.1 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 cost component of the analysis thus comprises the monies students pay (in the form of tuition and fees and forgone time and money), and the benefit component focuses on the extent to which the students' incomes increase as a result of their education.

3.1.1 Calculating student costs

Student costs consist of two main items: direct outlays and opportunity costs. Direct outlays include tuition and fees, equal to $28.5 million from Table 1.2. Direct outlays also include the cost of books and supplies. On average, full-time students spent $1,063 each on books and supplies during the reporting year.[13] Multiplying this figure times the number of full-time equivalents (FTEs) produced by TCUs in 2013-14[14] generates a total cost of $12.4 million for books and supplies.

Opportunity cost is the most difficult component of student costs to estimate. It measures the value of time and earnings forgone by students who go to college rather than work. To calculate it, we need to know the difference between the students' full earning potential and what they actually earn while attending college.

We derive the students' full earning potential by weighting the average annual income levels in Table 1.7 according to the education level breakdown of the student population when they first enrolled.[15] However, the income levels in Table 1.7 reflect what average workers earn at the midpoint of their careers, not while attending college. Because of this, we adjust the income levels to the average age of

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[13] Based on the data supplied by TCUs.

[14] A single FTE is equal to 30 CHEs, so there were 11,653 FTEs produced by students of TCUs in 2013-14, equal to 349,576 CHEs divided by 30 (excluding the CHE production of personal enrichment students).

[15] Based on the number of students who reported their entry level of education to TCUs.

the student population (30) to better reflect their wages at their current age.[16] This calculation yields an average full earning potential of $24,234 per student.

In determining what students earn while attending college, an important factor to consider is the time that they actually spend at college, since this is the only time that they are required to give up a portion of their earnings. 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 greater their forgone earnings. Overall, students of TCUs earned an average of 13.0 CHEs per student (excluding personal enrichment students), which is approximately equal to 43 percent of a full academic year.[17] We thus include no more than $10,509 (or 43 percent) of the students' full earning potential in the opportunity cost calculations.

Another factor to consider is the students' employment status while attending college. Based on data supplied by TCUs, an estimated 43 percent of their students are employed. For the 57 percent that are not working, we assume that they are either seeking work or planning to seek work once they complete their educational goals (with the exception of personal enrichment students, who are not included in this calculation). By choosing to go to college, non-working students give up everything that they can potentially earn during the academic year (i.e., the $10,509). The total value of their forgone income thus comes to $147.6 million.

Working students are able to maintain all or part of their income while enrolled. However, many of them hold jobs that pay less than statistical averages, usually because those are the only jobs they can find that accommodate their course schedule. These jobs tend to be at entry level, such as restaurant servers or cashiers. To account for this, we assume that working students hold jobs that pay 58 percent of what they would have earned had they chosen to work full-time rather than go to college.[18] The remaining 42 percent comprises the percent of their full earning potential that they forgo. Obviously this assumption varies by person – some students forego more and others less. Without knowing the actual jobs that students hold while attending, however, the 42 percent in forgone earnings serves as a reasonable average.

Working students also give up a portion of their leisure time in order to go to school, and mainstream theory places a value on this.[19] According to the Bureau of Labor Statistics American Time Use Survey,

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[16] We use the lifecycle earnings function identified by Jacob Mincer to scale the income levels to the students' current age. See Jacob Mincer, "Investment in Human Capital and Personal Income Distribution," *Journal of Political Economy,* vol. 66 issue 4, August 1958: 281-302. Further discussion on the Mincer function and its role in calculating the students' return on investment appears later in this chapter and in Appendix 4.

[17] Equal to 13.0 CHEs divided by 30, the assumed number of CHEs in a full-time academic year.

[18] The 58% assumption is based on the average hourly wage of the jobs most commonly held by working students divided by the national average hourly wage. Occupational wage estimates are published by the Bureau of Labor Statistics (see http://www.bls.gov/oes/current/oes_nat.htm).

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

students forgo up to 1.4 hours of leisure time per day.[20] Assuming that an hour of leisure is equal in value to an hour of work, we derive the total cost of leisure by multiplying the number of leisure hours foregone during the academic year by the average hourly pay of the students' full earning potential. For working students, therefore, their total opportunity cost comes to $67 million, equal to the sum of their foregone income ($47.7 million) and forgone leisure time ($19.3 million).

The steps leading up to the calculation of student costs appear in Table 3.1. Direct outlays amount to $38.8 million, the sum of tuition and fees ($28.5 million) and books and supplies ($12.4 million), less $2.1 million in direct outlays for personal enrichment students (these students are excluded from the cost calculations). Opportunity costs for working and non-working students amount to $155.3 million, excluding $59.3 million in offsetting residual aid that is paid directly to students. Summing all values together yields a total of $194.1 million in student costs.

Table 3.1: Student costs, 2013-14 (thousands)

Direct outlays	
Tuition and fees	$28,491
Books and supplies	$12,397
Less direct outlays of personal enrichment students	-$2,076
Total direct outlays	**$38,812**
Opportunity costs	
Earnings forgone by non-working students	$147,645
Earnings forgone by working students	$47,690
Value of leisure time forgone by working students	$19,332
Less residual aid	-$59,349
Total opportunity costs	**$155,318**
Total student costs	**$194,129**

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

3.1.2 Linking education to earnings

Having estimated the costs of education to students, we weigh these costs against the benefits that students receive in return. The relationship between education and earnings is well documented and forms the basis for determining student benefits. As shown in Table 1.7, mean income levels at the midpoint of the average-aged worker's career increase as people achieve higher levels of education. The differences between income levels define the upper bound benefits of moving from one education level to the next.[21]

A key component in determining the students' return on investment is the value of their future benefits stream, i.e., what they can expect to earn in return for the investment they make in education. We

[20] "Charts by Topic: Leisure and sports activities," Bureau of Labor Statistics American Time Use Survey, last modified November 2012, accessed July 2013, http://www.bls.gov/TUS/CHARTS/LEISURE.HTM.

[21] As discussed in Appendix 4, the upper bound benefits of education must be controlled for participant characteristics that also correlate with future wage increases, including inherent ability, socioeconomic status, and family background.

calculate the future benefits stream to TCU 2013-14 students first by determining their average annual increase in income, equal to $61.2 million. This value represents the higher income that accrues to students at the midpoint of their careers and is calculated based on the marginal wage increases of the CHEs that students complete while attending college. For a full description of the methodology used to derive the $61.2 million, see Appendix 4.

The second step is to project the $61.2 million annual increase in income into the future, for as long as students remain in the workforce. We do this by applying a set of scalars derived from the slope of the earnings function developed by Jacob Mincer to predict the change in earnings at each age in an individual's working career.[22] Appendix 4 provides more information on the Mincer function and how it is used to predict future earnings growth. With the $61.2 million representing the students' higher earnings at the midpoint of their careers, we apply scalars from the Mincer function to yield a stream of projected future benefits that 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 retirement at age 67. This earnings stream appears in Column 2 of Table 3.2.

Table 3.2: Projected benefits and costs, student perspective

1 Year	2 Gross added income to students (millions)	3 Less adjustments (millions)*	4 Net added income to students (millions)	5 Student costs (millions)	6 Net cash flow (millions)
0	$34.3	$0.1	$2.3	$194.1	-$191.8
1	$35.8	$0.2	$6.9	$0.0	$6.9
2	$37.4	$0.3	$10.5	$0.0	$10.5
3	$39.0	$0.4	$16.8	$0.0	$16.8
4	$40.6	$0.6	$26.3	$0.0	$26.3
5	$42.2	$0.9	$39.6	$0.0	$39.6
6	$43.8	$0.9	$41.2	$0.0	$41.2
7	$45.4	$0.9	$42.7	$0.0	$42.7
8	$47.0	$0.9	$44.2	$0.0	$44.2
9	$48.6	$0.9	$45.7	$0.0	$45.7
10	$50.2	$0.9	$47.2	$0.0	$47.2
11	$51.8	$0.9	$48.6	$0.0	$48.6
12	$53.3	$0.9	$50.0	$0.0	$50.0
13	$54.8	$0.9	$51.4	$0.0	$51.4
14	$56.2	$0.9	$52.7	$0.0	$52.7
15	$57.6	$0.9	$53.9	$0.0	$53.9
16	$59.0	$0.9	$55.1	$0.0	$55.1
17	$60.3	$0.9	$56.2	$0.0	$56.2
18	$61.6	$0.9	$57.2	$0.0	$57.2
19	$62.8	$0.9	$58.2	$0.0	$58.2

[22] See Mincer, 1958.

Table 3.2: Projected benefits and costs, student perspective

1 Year	2 Gross added income to students (millions)	3 Less adjustments (millions)*	4 Net added income to students (millions)	5 Student costs (millions)	6 Net cash flow (millions)
20	$63.9	$0.9	$59.1	$0.0	$59.1
21	$65.0	$0.9	$59.8	$0.0	$59.8
22	$66.0	$0.9	$60.5	$0.0	$60.5
23	$66.9	$0.9	$61.1	$0.0	$61.1
24	$67.7	$0.9	$61.5	$0.0	$61.5
25	$68.5	$0.9	$61.9	$0.0	$61.9
26	$69.1	$0.9	$62.1	$0.0	$62.1
27	$69.7	$0.9	$62.2	$0.0	$62.2
28	$70.1	$0.9	$62.2	$0.0	$62.2
29	$70.5	$0.9	$60.1	$0.0	$60.1
30	$70.8	$0.8	$56.3	$0.0	$56.3
31	$67.6	$0.8	$54.2	$0.0	$54.2
32	$67.7	$0.8	$52.6	$0.0	$52.6
33	$62.2	$0.8	$46.7	$0.0	$46.7
34	$61.2	$0.7	$42.8	$0.0	$42.8
35	$59.9	$0.7	$38.9	$0.0	$38.9
36	$50.6	$0.6	$29.7	$0.0	$29.7
37	$47.3	$0.5	$23.2	$0.0	$23.2
38	$43.4	$0.4	$17.8	$0.0	$17.8
39	$29.3	$0.5	$13.9	$0.0	$13.9
40	$19.1	$0.5	$9.5	$0.0	$9.5
41	$18.1	$0.3	$5.9	$0.0	$5.9
42	$14.3	$0.2	$3.3	$0.0	$3.3
43	$8.8	$0.3	$2.5	$0.0	$2.5
44	$5.0	$0.1	$0.7	$0.0	$0.7
45	$2.6	$0.1	$0.2	$0.0	$0.2
Present value			**$794.3**	**$194.1**	**$600.2**
Internal rate of return					**16.6%**
Benefit-cost ratio					**4.1**
Payback period (no. of years)					**8.2**

* Includes the "settling-in" factors and attrition.

Source: EMSI impact model.

As shown in Table 3.2, the $61.2 million in gross added income occurs at Year 18, which is the approximate midpoint of the students' future working careers, given the average age of the student population and an assumed retirement age of 67. In accordance with Mincer function, the gross added income that accrues to students in the years leading up to the midpoint is less than $61.2 million, and the gross added income in the years after the midpoint is greater than $61.2 million.

The final step in calculating the students' future benefits stream is to net out the potential benefits generated by students who are either not yet active in the workforce or who leave the workforce over time. This adjustment appears in Column 3 of Table 3.2 and represents the percentage of the total 2013-14 student population that will be employed in the workforce in a given year. Note that the percentages in the first five years of the time horizon are relatively lower than those in subsequent years. This is because many students delay their entry into the workforce, either because they are still enrolled in TCUs or because they are unable to find a job immediately upon graduation. Accordingly, we apply a set of "settling-in" factors to account for the time needed by students to find employment and settle into their careers. As discussed in Chapter 2, settling-in factors delay the onset of the benefits by one to three years for students who graduate with a certificate or a degree, and by one to five years for returning students and transfer track students. We apply no settling-in factors to the benefits for workforce and professional development students because the majority of them are employed while attending.

Beyond the first five years of the time horizon, students will leave the workforce over time for any number of reasons, whether because of death, retirement, or unemployment. We estimate the rate of attrition using the same data and assumptions applied in the calculation of the attrition rate in the economic impact analysis of Chapter 2.[23] The likelihood that students leave the workforce increases as they age, so the attrition rate is more aggressive near the end of the time horizon than in the beginning. Column 4 of Table 3.2 shows the net added income to students after accounting for both the settling-in patterns and attrition.

3.1.3 Return on investment to students

Having estimated the students' costs and their future benefits stream, the next step is to discount the results to the present to reflect the time value of money. For the student perspective we assume a discount rate of 4.5 percent (see the "Discount Rate" box).[24] The present value of the benefits is then compared to student costs to derive the investment analysis results, expressed in terms of a benefit-cost ratio, rate of return, and payback period. The 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 short payback period.

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[23] See the discussion of the alumni impact in Chapter 2. The main sources for deriving the attrition rate are the National Center for Health Statistics, the Social Security Administration, and the Bureau of Labor Statistics. Note that we do not account for migration patterns in the student investment analysis because the higher earnings that students receive as a result of their education will accrue to them regardless of where they find employment.

[24] The student discount rate is derived from the baseline forecasts for the ten-year zero coupon bond discount rate published by the Congressional Budget Office. See the Congressional Budget Office, Student Loan and Pell Grant Programs - March 2012 Baseline, Congressional Budget Office Publications, last modified March 13, 2012, accessed July 2013, http://www.cbo.gov/sites/default/files/cbofiles/attachments/43054_StudentLoanPellGrantPrograms.pdf.

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 4.5 percent discount rate from the student perspective and a 1.1 percent discount rate from the taxpayer perspective. The discount rate for taxpayers is lower than it is for students because governments are large and can therefore spread their risks over a larger and more diverse investment portfolio than the private sector can.

In Table 3.2, the net added income of students of TCUs yields a cumulative discounted sum of approximately $794.3 million, the present value of all of the future income increments (see the bottom section of Column 4). This may also be interpreted as the gross capital asset value of the students' higher income stream. In effect, the aggregate 2013-14 student body is rewarded for their investment in TCUs with a capital asset valued at $794.3 million.

The students' cost of attending TCUs is shown in Column 5 of Table 3.2, equal to a present value of $194.1 million. Note that costs only occur in the single analysis year and are thus already in current-year dollars. Comparing the cost with the present value of benefits yields a student benefit-cost ratio of 4.1 (equal to $794.3 million in benefits divided by $194.1 million in costs).

Another way to compare the same benefits stream and associated cost is to compute the rate of return. The rate of return indicates the interest rate that a bank would have to pay a depositor to yield an equally attractive stream of future payments.[25] Table 3.2 shows TCU students earning average returns of 16.6 percent on their investment of time and money. This is a favorable return compared, for example, to approximately 1 percent on a standard bank savings account, or 7 percent on stocks and bonds (thirty-year average return).

Note that returns reported in this study 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 percent and a nominal percentage of 5 percent is paid, then the real rate of return on the

[25] 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. Someone who invests in education, 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.

investment is only 2 percent. In Table 3.2, the 16.6 percent student rate of return is a real rate. With an inflation rate of 2.5 percent (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 19.1 percent, substantially higher than what is reported in Table 3.2.

The payback period is defined as the length of time it takes to entirely recoup the initial investment.[26] Beyond that point, returns are what economists would call "pure costless rent." As indicated in Table 3.2, students at TCUs see, on average, a payback period of 8.2 years on their forgone earnings and out-of-pocket costs.

3.2 Social perspective

Society as a whole in the U.S. benefits from the education that TCUs provide through the income that students create in the nation and through the savings that they generate through their improved lifestyles. To receive these benefits, however, members of society must pay money and forgo services that they would have otherwise enjoyed if TCUs did not exist. Society's investment in TCUs stretches across a number of investor groups, from students to employers to taxpayers. We weigh the benefits generated by TCUs to society against the total societal costs of generating those benefits. The total societal costs include all TCUs' expenditures, all student expenditures, and all student opportunity costs, totaling $572.5 million (= $406.8 million in TCUs' expenditures + $10.3 million in student expenditures + $155.3 million in student opportunity costs).

On the benefits side, any benefits that accrue to society as a whole – including students, employers, taxpayers, and anyone else who stands to benefit from the activities of TCUs – are counted as benefits under the social perspective. We group these benefits under the following broad headings: 1) increased income in the nation, and 2) social externalities stemming from improved health, reduced crime, and reduced unemployment in the nation (see the "Beekeeper Analogy" box for a discussion of externalities). Both of these benefits components are described more fully in the following sections.

[26] 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. The payback period is calculated by dividing the cost of the investment by the net return per period. In this study, the cost of the investment includes tuition and fees plus the opportunity cost of time – it does not take into account student living expenses or interest on loans.

Beekeeper Analogy

Beekeepers provide a classic example of positive externalities (sometimes called "neighborhood effects"). The beekeeper's intention is to make money selling honey. Like any other business, receipts must at least cover operating costs. If they don't, the business shuts down.

But from society's standpoint there is more. Flowers provide the nectar that 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 like beekeepers. While their principal aim is to provide education and raise people's incomes, in the process an array of external benefits are created. Students' health and lifestyles are improved, and society indirectly benefits just as orchard owners indirectly benefit from beekeepers. Aiming at a more complete accounting of the benefits of taxpayer expenditures on education, the model tracks and accounts for many of these external social benefits.

It is important to note that by comparing benefits to society against costs to taxpayers, we are including more benefits than a standard investment analysis typically allows. As such, most of the standard measures used in investment analysis (i.e., the net present value, rate of return, and payback period) no longer apply. Under the social perspective, we only present the benefit-cost ratio, recognizing that the benefits component accrues to a lot more people than just the taxpayers and that, because of this, the results calculated on the basis of those benefits should be viewed strictly as a comparison between public benefits and taxpayer costs.

3.2.1 Income growth in the nation

In the process of absorbing the newly acquired skills of students of TCUs, not only does the productivity of the U.S. workforce increase, but so does the productivity of its physical capital and assorted infrastructure. Students earn more because of the skills they learned while attending one of the TCUs, 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 non-labor (i.e., capital) income are considered the effect of a skilled workforce.

Estimating the effect of TCUs on income growth in the nation begins with the present value of the students' future income stream, which is displayed in Column 4 of Table 3.2. To this we apply a multiplier derived from EMSI's SAM model to estimate the added labor income created in the nation as students and businesses spend their higher incomes.[27] As labor income increases, so does non-labor

[27] For a full description of the EMSI SAM model, see Appendix 3.

income, which consists of monies gained through investments. To calculate the growth in non-labor income, we multiply the increase in labor income by a ratio of Gross Domestic Product to total labor income in the nation.

We apply another reduction factor to account for the students' alternative education opportunities. This is the same adjustment that we use in the calculation of the alumni impact in Chapter 2 and is designed to account for the counterfactual scenario where TCUs do not exist. The assumption in this case is that any benefits generated by students who could have received an education even without TCUs cannot be counted as new benefits to society.[28] For this analysis, we assume an alternative education variable of 15 percent, meaning that 15 percent of the student population at TCUs would have generated benefits anyway even without the TCUs. For more information on the calculation of the alternative education variable, please see Appendix 5.

After adjusting for alternative education opportunities, we calculate the present value of the future added income that occurs in the nation, equal to $2.7 billion (this value appears again later in this chapter in Table 3.3). Recall from the discussion of the student return on investment that the present value represents the sum of the future benefits that accrue each year over the course of the time horizon, discounted to current-year dollars to account for the time value of money. The discount rate in this case is 1.1 percent, the real treasury interest rate recommended by the Office for Management and Budget (OMB) for 30-year investments.[29]

3.2.2 Social savings

In addition to the creation of higher income in the U.S., education is statistically associated with a variety of lifestyle changes that generate social savings, also known as external or incidental benefits of education. These represent the avoided costs that would have otherwise been drawn from private and public resources absent the education provided by TCUs. Social benefits appear in Table 3.3 and break down into three main categories: 1) health savings, 2) crime savings, and 3) welfare and unemployment savings. Health savings include avoided medical costs, lost productivity, and other effects associated with smoking, alcoholism, obesity, mental illness, and drug abuse. Crime savings consist of avoided costs to the justice system (i.e., police protection, judicial and legal, and corrections), avoided victim costs, and 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.

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[28] A situation in which there were no public institutions in the nation is virtually impossible. The adjustment is entirely hypothetical and is used merely to examine TCUs in standard investment analysis terms by accounting for benefits that would have occurred anyway, even if the TCUs did not exist.

[29] See the Office of Management and Budget, Real Treasury Interest Rates in "Table of Past Years Discount Rates" from Appendix C of OMB Circular No. A-94 (revised December 2012).

The model quantifies social savings 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 from a variety of studies and surveys analyzing the correlation between education and health, crime, welfare, and unemployment at the national level. We spread the probabilities across the education ladder and multiply the marginal differences by the number of students who achieved CHEs at each step. The sum of these marginal differences counts as the upper bound measure of the number of students who, due to the education they received at TCUs, will not have poor health, commit crimes, or claim welfare and unemployment benefits. We dampen these results by the "ability bias" adjustment discussed earlier in this chapter and in Appendix 4 to account for other factors besides education that influence individual behavior. We then multiply the marginal effects of education times the associated costs of health, crime, welfare, and unemployment.[30] Finally, we apply the same adjustments for attrition and alternative education to derive the net savings to society.

Table 3.3: Present value of the future added income and social savings in the nation (thousands)

Added Income	**$2,699,222**
Social Savings	
Health	
Smoking	$95,944
Alcoholism	$3,654
Obesity	$40,132
Mental illness	$33,982
Drug abuse	$4,800
Total health savings	**$178,511**
Crime	
Criminal Justice System savings	$14,350
Crime victim savings	$909
Added productivity	$2,316
Total crime savings	**$17,574**
Welfare/unemployment	
Welfare savings	$152
Unemployment savings	$314
Total welfare/unemployment savings	**$466**
Total social savings	**$196,551**
Total, added income + social savings	**$2,895,773**

Source: EMSI impact model.

Table 3.3 above displays the results of the analysis. The first row shows the added income created in the nation, equal to $2.7 billion. Social savings appear next, beginning with a breakdown of savings related to health. These savings amount to a present value of $178.5 million, including savings due to

[30] For a full list of the data sources used to calculate the social externalities, see the Resources and References section. See also Appendix 7 for a more in-depth description of the methodology.

a reduced demand for medical treatment and social services, improved worker productivity and reduced absenteeism, and a reduced number of vehicle crashes and fires induced by alcohol or smoking-related incidents. Crime savings sum to $17.6 million, including savings 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, the present value of the savings related to welfare and unemployment amount to $465,899, stemming from a reduced number of persons in need of income assistance. All told, social savings amounted to $196.6 million in benefits to society as a whole in U.S.

The sum of the social savings and the added income in the nation is $2.9 billion, as shown in the bottom row of Table 3.3. These savings accrue for years out into the future, for as long as TCU 2013-14 students remain in the workforce.

3.2.3 Return on investment to society

Table 3.4 presents the stream of benefits accruing to society and the total societal costs of generating those benefits. Comparing the present value of the benefits to society and the societal costs, we have a benefit-to-cost ratio of 5.2. This means that for every dollar society invests in educations from TCUs, whether it is the money spent on day-to-day operations of the TCUs or money spent by students on tuition and fees, an average of $5.20 in benefits will accrue to society.

Table 3.4: Projected benefits and costs, social perspective

1	2	3	4
Year	**Benefits to society (millions)**	**Societal costs (millions)**	**Net cash flow (millions)**
0	$5.0	$572.5	-$567.5
1	$14.8	$0.0	$14.8
2	$22.2	$0.0	$22.2
3	$35.5	$0.0	$35.5
4	$55.3	$0.0	$55.3
5	$82.8	$0.0	$82.8
6	$85.7	$0.0	$85.7
7	$88.6	$0.0	$88.6
8	$91.4	$0.0	$91.4
9	$94.2	$0.0	$94.2
10	$96.9	$0.0	$96.9
11	$99.6	$0.0	$99.6
12	$102.2	$0.0	$102.2
13	$104.7	$0.0	$104.7
14	$107.1	$0.0	$107.1
15	$109.4	$0.0	$109.4
16	$111.6	$0.0	$111.6
17	$113.6	$0.0	$113.6
18	$115.5	$0.0	$115.5

Table 3.4: Projected benefits and costs, social perspective

1	2	3	4
Year	Benefits to society (millions)	Societal costs (millions)	Net cash flow (millions)
19	$117.2	$0.0	$117.2
20	$118.8	$0.0	$118.8
21	$120.2	$0.0	$120.2
22	$121.4	$0.0	$121.4
23	$122.5	$0.0	$122.5
24	$123.3	$0.0	$123.3
25	$123.9	$0.0	$123.9
26	$124.2	$0.0	$124.2
27	$124.4	$0.0	$124.4
28	$124.3	$0.0	$124.3
29	$120.1	$0.0	$120.1
30	$112.3	$0.0	$112.3
31	$108.6	$0.0	$108.6
32	$105.4	$0.0	$105.4
33	$94.2	$0.0	$94.2
34	$86.3	$0.0	$86.3
35	$78.7	$0.0	$78.7
36	$61.0	$0.0	$61.0
37	$47.9	$0.0	$47.9
38	$37.1	$0.0	$37.1
39	$30.6	$0.0	$30.6
40	$22.6	$0.0	$22.6
41	$14.1	$0.0	$14.1
42	$8.3	$0.0	$8.3
43	$7.3	$0.0	$7.3
44	$2.7	$0.0	$2.7
45	$1.0	$0.0	$1.0
Present value	**$2,956.9**	**$572.5**	**$2,384.5**
Benefit-cost ratio			**5.2**

Source: EMSI impact model.

3.3 Taxpayer perspective

From the taxpayer perspective, the pivotal step here is to limit overall public benefits shown in Tables 3.3 and 3.4 to those that specifically accrue to government. For example, benefits resulting from income growth are limited to increased tax payments. Similarly, savings related to improved health, reduced crime, and fewer welfare and unemployment claims are limited to those received strictly by government. In all instances, benefits to private residents or businesses are excluded.

3.3.1 Benefits to taxpayers

Table 3.5 presents the present value of the benefits to taxpayers. Added tax revenue appears in the first row. These figures are derived by multiplying the income growth figures from Table 3.3 by the prevailing government tax rates. For the social externalities, we claim only the benefits that reduce the demand for government-supported social services, or the benefits resulting from improved productivity among government employees. The present value of future tax revenues and government savings thus comes to approximately $761.2 million.

Table 3.5: Present value of added tax revenue and government savings (thousands)

Added tax revenue	**$715,125**
Government savings	
Health-related savings	$30,909
Crime-related savings	$14,670
Welfare/unemployment-related savings	$466
Total government savings	$46,045
Total taxpayer benefits	**$761,170**

Source: EMSI impact model.

3.3.2 Return on investment

Taxpayer costs are reported in Table 3.6 and come to $337.9 million, equal to the contribution of local, state, and federal government to TCUs. In return for their public support, therefore, taxpayers are rewarded with an investment benefit-cost ratio of 2.4 (= $761.2 million ÷ $337.9 million), indicating a profitable investment.

Table 3.6: Projected benefits and costs, taxpayer perspective

1 Year	2 Benefits to taxpayers (millions)	3 Gov't costs (millions)	4 Net cash flow (millions)
0	$1.4	$337.9	-$336.5
1	$4.0	$0.0	$4.0
2	$6.0	$0.0	$6.0
3	$9.6	$0.0	$9.6
4	$15.0	$0.0	$15.0
5	$22.5	$0.0	$22.5
6	$23.2	$0.0	$23.2
7	$24.0	$0.0	$24.0
8	$24.7	$0.0	$24.7
9	$25.5	$0.0	$25.5
10	$26.2	$0.0	$26.2
11	$26.9	$0.0	$26.9
12	$27.6	$0.0	$27.6
13	$28.3	$0.0	$28.3

Table 3.6: Projected benefits and costs, taxpayer perspective

1 Year	2 Benefits to taxpayers (millions)	3 Gov't costs (millions)	4 Net cash flow (millions)
14	$28.9	$0.0	$28.9
15	$29.5	$0.0	$29.5
16	$30.1	$0.0	$30.1
17	$30.6	$0.0	$30.6
18	$31.1	$0.0	$31.1
19	$31.6	$0.0	$31.6
20	$32.0	$0.0	$32.0
21	$32.4	$0.0	$32.4
22	$32.7	$0.0	$32.7
23	$33.0	$0.0	$33.0
24	$33.2	$0.0	$33.2
25	$33.3	$0.0	$33.3
26	$33.4	$0.0	$33.4
27	$33.5	$0.0	$33.5
28	$33.4	$0.0	$33.4
29	$32.3	$0.0	$32.3
30	$30.2	$0.0	$30.2
31	$29.2	$0.0	$29.2
32	$28.4	$0.0	$28.4
33	$25.4	$0.0	$25.4
34	$23.3	$0.0	$23.3
35	$21.2	$0.0	$21.2
36	$16.5	$0.0	$16.5
37	$13.0	$0.0	$13.0
38	$10.1	$0.0	$10.1
39	$8.4	$0.0	$8.4
40	$6.3	$0.0	$6.3
41	$3.9	$0.0	$3.9
42	$2.3	$0.0	$2.3
43	$2.1	$0.0	$2.1
44	$0.8	$0.0	$0.8
45	$0.3	$0.0	$0.3
Present value	**$798.2**	**$337.9**	**$460.3**
Internal rate of return			**6.2%**
Benefit-cost ratio			**2.4**
Payback period (no. of years)			**16.5**

Source: EMSI impact model.

At 6.2 percent, the rate of return to taxpayers is also favorable. As above, we assume a 1.1 percent discount rate 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 1.1 percent would mean that the TCUs just pay their own way. In principle, governments could borrow monies used to support TCUs and repay the loans out of the resulting added taxes and reduced government expenditures. A rate of return of 6.2 percent, on the other hand, means that TCUs not only pay their own way, but also generate a surplus that governments can use to fund other programs. It is unlikely that other government programs could make such a claim.

3.3.3 With and without social savings

Earlier in this chapter, social benefits attributable to education (reduced crime, lower welfare, lower unemployment, and improved health) were defined as externalities that are incidental to the operations of TCUs. Some would question the legitimacy of including these benefits in the calculation of rates of return to education, arguing that only the tangible benefits, i.e., higher income, should be counted. Tables 3.4 and 3.6 are inclusive of social benefits reported as attributable to TCUs. Recognizing the other point of view, Table 3.7 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 1.0 and a rate of return greater than 1.1 percent), confirming that taxpayers receive value from investing in TCUs.

Table 3.7: Social and taxpayer perspectives with and without social savings

	Including social savings	Excluding social savings
Social perspective		
Net present value	$2,384,453	$2,275,665
Benefit-cost ratio	5.2	5.0
Taxpayer perspective		
Net present value	$460,305	$377,265
Benefit-cost ratio	2.4	2.1
Internal rate of return	6.2%	5.4%
Payback period (no. of years)	16.5	17.9

Source: EMSI impact model.

3.4 Conclusion

This chapter has shown that TCUs are an attractive investment to their major stakeholders – students, tribes, society, and taxpayers. Rates of return to students invariably exceed alternative investment opportunities. At the same time, the government 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 public sector savings provided by the educational activities of TCUs and their students, the government would have to raise taxes to make up for lost revenues and added costs.

Chapter 4: Sensitivity Analysis

Sensitivity analysis is the process by which researchers determine how sensitive the outputs of the model are to variations in the background data and assumptions, especially if there is any uncertainty in the variables. Sensitivity analysis is also useful for identifying a plausible range wherein the results will fall should any of the variables deviate from expectations. In this chapter we test the sensitivity of the model to the following input factors: 1) the alternative education variable, 2) the student employment variables, and 3) the discount rate.

4.1 Alternative education variable

The alternative education variable (15 percent) accounts for the counterfactual scenario where students would have to seek a similar education elsewhere absent TCUs. Given the difficulty in accurately specifying the alternative education variable, we test the sensitivity of the taxpayer investment analysis results to its magnitude. Variations in the alternative education assumption are calculated around base case results listed in the middle column of Table 4.1. Next, the model brackets the base case assumption on either side with a plus or minus 10 percent, 25 percent, and 50 percent variation in assumptions. Analyses are then redone introducing one change at a time, holding all other variables constant. For example, an increase of 10 percent in the alternative education assumption (from 15 percent to 17 percent) reduces the taxpayer perspective rate of return from 6.2 percent to 6.1 percent. Likewise, a decrease of 10 percent (from 15 percent to 14 percent) in the assumption increases the rate of return from 6.2 percent to 6.3 percent.

Table 4.1: Sensitivity analysis of alternative education variable, taxpayer perspective

% variation in assumption	-50%	-25%	-10%	Base Case	10%	25%	50%
Alternative education variable	8%	11%	14%	15%	17%	19%	23%
Net present value (millions)	$531	$496	$474	$460	$446	$425	$390
Rate of return	6.8%	6.5%	6.3%	6.2%	6.1%	5.9%	5.6%
Benefit-cost ratio	2.6	2.5	2.4	2.4	2.3	2.3	2.2

Based on this sensitivity analysis, the conclusion can be drawn that TCUs' 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 1.1 percent), even when the alternative education assumption is increased by as much as 50 percent (from 15 percent to 23 percent). 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.

4.2 Student employment variables

Student employment variables are difficult to estimate because many students do not report their employment status or because the TCUs generally do not collect this kind of information.

Employment variables include the following: 1) the percentage of students that are employed while attending college, and 2) the percentage of earnings that working students receive relative to the income they would have received had they not chosen to attend college. Both employment variables affect the investment analysis results from the student perspective.

Students incur substantial expense by attending TCUs because of the time they spend not gainfully employed. Some of that cost is recaptured if students remain partially (or fully) employed while attending. Based on data supplied by the TCUs, it is estimated that 43 percent of students who reported their employment status are employed. This variable is tested in the sensitivity analysis by changing it first to 100 percent and then to 0 percent.

The second student employment variable is more difficult to estimate. In this study we estimate that students that are working while attending college earn only 58 percent, on average, of the income that they would have statistically received if not attending TCUs. This suggests that many students hold part-time jobs that accommodate their TCUs attendance, though it is at an additional cost in terms of receiving a wage that is less than what they might otherwise make. The 58 percent variable is an estimation based on the average hourly wages of the most common jobs held by students while attending college relative to the average hourly wages of all occupations in the U.S. The model captures this difference in wages and counts it as part of the opportunity cost of time. As above, the 58 percent estimate is tested in the sensitivity analysis by changing it to 100 percent and then to 0 percent.

The changes generate results summarized in Table 4.2, 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 43 percent and B equal to 58 percent. Sensitivity analysis results are shown in non-shaded rows. Scenario 1 increases A to 100 percent while holding B constant, Scenario 2 increases B to 100 percent while holding A constant, Scenario 3 increases both A and B to 100 percent, and Scenario 4 decreases both A and B to 0 percent.

Table 4.2: Sensitivity analysis of student employment variables

Variations in assumptions	Net present value (millions)	Internal rate of return	Benefit-cost ratio
Base case: A = 43%, B = 58%	$600.2	16.6%	4.1
Scenario 1: A = 100%, B = 58%	$659.8	21.5%	5.9
Scenario 2: A = 43%, B = 100%	$647.9	20.3%	5.4
Scenario 3: A = 100%, B = 100%	$770.1	69.1%	32.9
Scenario 4: A = 0%, B = 0%	$554.7	14.2%	3.3

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

1. Scenario 1: Increasing the percent of students employed (A) from 43 percent to 100 percent, the net present value, internal rate of return, and benefit-cost ratio improve to $659.8 million, 21.5 percent, and 5.9, 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 58 percent to 100 percent, the net present value, internal rate of return, and benefit-cost ratio results improve to $647.9 million, 20.3 percent, and 5.4, 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 percent simultaneously, the net present value, internal rate of return, and benefit-cost ratio improve yet further to $770.1 million, 69.1 percent, and 32.9, 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 percent reduces the net present value, internal rate of return, and benefit-cost ratio to $554.7 million, 14.2 percent, and 3.3, respectively, relative to base case results. These results are reflective of an increased opportunity cost – none of the students are employed in this case.[31]

It is strongly emphasized in this section that base case results are very attractive in that results are all above their threshold levels. As is clearly demonstrated here, results of the first three alternative scenarios appear much more attractive, although they overstate benefits. Results presented in Chapter 3 are realistic, indicating that investments in TCUs generate excellent returns, well above the long-term average percent rates of return in stock and bond markets.

4.3 Discount rate

The discount rate is a rate of interest that converts future monies to their present value. In investment analysis, the discount rate accounts for two fundamental principles: 1) the time value of money, and 2) the level of risk that an investor is willing to accept. Time value of money refers to the value of money after interest or inflation has accrued over a given length of time. An investor must be willing to forgo the use of his money in the present if he wishes to receive compensation for it in the future. The discount rate also addresses the investors' risk preferences by serving as a proxy for the minimum rate of return that the proposed risky asset must be expected to yield before the investors will be persuaded to invest in it. Typically this minimum rate of return is determined by the known returns of less risky assets where the investors might alternatively consider placing their money.

In this study, we assume a 4.5 percent discount rate for students and a 1.1 percent discount rate for society and taxpayers.[32] Similar to the sensitivity analysis of the alternative education variable, we vary the base case discount rates for students, society, and taxpayers on either side by increasing the

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[31] 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.

[32] These values are based on the baseline forecasts for the ten-year zero coupon bond discount rate published by the Congressional Budget Office, and the real treasury interest rates recommended by the Office for Management and Budget (OMB) for 30-year investments. See the Congressional Budget Office, Student Loan and Pell Grant Programs - March 2012 Baseline, and the Office of Management and Budget, Circular A-94 Appendix C, last modified December 2012.

discount rate by 10 percent, 25 percent, and 50 percent, and then reducing it by 10 percent, 25 percent, and 50 percent. Note that, because the rate of return and the payback period are both based on the undiscounted cash flows, they are unaffected by changes in the discount rate. As such, only variations in the net present value and the benefit-cost ratio are shown for students, society, and taxpayers in Table 4.3.

Table 4.3: Sensitivity analysis of discount rate

% variation in assumption	-50%	-25%	-10%	Base Case	10%	25%	50%
Student perspective							
Discount rate	2.2%	3.4%	4.0%	4.5%	4.9%	5.6%	6.7%
Net present value (millions)	$975	$764	$661	$600	$545	$473	$451
Benefit-cost ratio	6.0	4.9	4.4	4.1	3.8	3.4	3.3
Social perspective							
Discount rate	0.6%	0.8%	1.0%	1.1%	1.2%	1.4%	1.7%
Net present value (millions)	$2,727	$2,550	$2,449	$2,384	$2,322	$2,230	$2,087
Benefit-cost ratio	5.8	5.5	5.3	5.2	5.1	4.9	4.6
Taxpayer perspective							
Discount rate	0.6%	0.8%	1.0%	1.1%	1.2%	1.4%	1.7%
Net present value (millions)	$553	$505	$478	$460	$443	$419	$380
Benefit-cost ratio	2.6	2.5	2.4	2.4	2.3	2.2	2.1

As demonstrated in the table, an increase in the discount rate leads to a corresponding decrease in the expected returns, and vice versa. For example, increasing the student discount rate by 50 percent (from 4.5 percent to 6.7 percent) reduces the students' benefit-cost ratio from 4.1 to 3.3. Conversely, reducing the discount rate for students by 50 percent (from 4.5 percent to 2.2 percent) increases the benefit-cost ratio from 4.1 to 6.0. The sensitivity analysis results for society and taxpayers show the same inverse relationship between the discount rate and the benefit-cost ratio, with the variance in results being the greatest under the social perspective (from a 5.8 benefit-cost ratio at a -50 percent variation from the base case to a 4.6 benefit-cost ratio at a 50 percent variation from the base case).

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Appendix 1: TCUs

Aaniiih Nakoda College	Harlem, Montana
Bay Mills Community College	Brimley, Michigan
Blackfeet Community College	Browning, Montana
Cankdeska Cikana Community College	Fort Totten, North Dakota
Chief Dull Knife College	Lame Deer, Montana
College of Menominee Nation	Keshena, Wisconsin
College of the Muscogee Nation	Okmulgee, Oklahoma
Diné College	Tsaile, Arizona
Fond du Lac Tribal and Community College	Cloquet, Minnesota
Fort Peck Community College	Poplar, Montana
Haskell Indian Nations University	Lawrence, Kansas
Ilisagvik College	Barrow, Alaska
Institute of American Indian Arts	Sante Fe, New Mexico
Keweenaw Bay Ojibwa Community College	Baraga, Michigan
Lac Courte Oreilles Ojibwa Community College	Hayward, Wisconsin
Leech Lake Tribal College	Cass Lake, Minnesota
Little Big Horn College	Crow Agency, Montana
Little Priest Tribal College	Winnebago, Nebraska
Navajo Technical University	Crownpoint, New Mexico
Nebraska Indian Community College	Macy, Nebraska
Northwest Indian College	Bellingham, Washington
Nueta Hidatsa Sahnish College[33]	New Town, North Dakota
Oglala Lakota College	Kyle, South Dakota
Saginaw Chippewa Tribal College	Mount Pleasant, Michigan
Salish Kootenai College	Pablo, Montana

[33] Formerly Fort Berthold Community College.

Sinte Gleska University	Mission, South Dakota
Sisseton Wahpeton College	Agency Village, South Dakota
Sitting Bull College	Fort Yates, North Dakota
Southwestern Indian Polytechnic Institute	Albuquerque, New Mexico
Stone Child College	Box Elder, Montana
Tohono O'odham Community College	Sells, Arizona
Turtle Mountain Community College	Belcourt, North Dakota
United Tribes Technical College	Bismarck, North Dakota
White Earth Tribal and Community College	Mahnomen, Minnesota

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 TCUs. An estimate of 10 percent, for example, means that 10 percent of students do not depend directly on the existence of the TCUs in order to obtain their education.

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 workforce due to out-migration, unemployment, 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 (tuition and fees) is lowered, or conversely, enrollment decreases if price increases.

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 (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 welfare and 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 Domestic Product Measure of the final value of all goods and services produced in the U.S. after netting out the cost of goods used in production. Alternatively, Gross Domestic Product (GDP) 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. GDP is also sometimes called "value added."

Initial effect Income generated by the initial injection of monies into the economy through the payroll of the TCUs and the higher earnings of their 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, 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 effect Additional income created in the economy as a result of the TCUs. It consists of the income created by the supply chain of the industries initially affected by their students (i.e., the direct effect), income created by the supply chain of the initial supply chain (i.e., the indirect effect), and the income created by the increased spending of the household sector (i.e., the induced effect).

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 received from investments, such as rent, interest, and dividends.
Opportunity cost	Benefits forgone from alternative B once a decision is made to allocate resources to alternative A. Or, if individuals choose to attend college, they forgo earnings that they would have received had they chosen instead to work full-time. Forgone earnings, therefore, are the "price tag" of choosing to attend college.
Payback period	Length of time required to recover an investment. The shorter the period, the more attractive the investment. The formula for computing payback period is: Payback period = cost of investment/net return per period

Appendix 3: EMSI MR-SAM

EMSI's Multi-Regional Social Accounting Matrix (MR-SAM) represents the flow of all economic transactions in a given region. It replaces EMSI's previous input-output (IO) model, which operated with some 1,100 industries, four layers of government, a single household consumption sector, and an investment sector. The old IO model was used to simulate the ripple effects (i.e., multipliers) in the regional economy as a result of industries entering or exiting the region. The SAM model performs the same tasks as the old IO model, but it also does much more. Along with the same 1,100 industries, government, household and investment sectors embedded in the old IO tool, the SAM exhibits much more functionality, a greater amount of data, and a higher level of detail on the demographic and occupational components of jobs (16 demographic cohorts and about 750 occupations are characterized).

This appendix presents a high-level overview of the MR-SAM. Additional detail on the technical aspects of the model is available upon request; however, we are unable to provide information that discloses confidential or proprietary methodology.

A3.1 Data sources for the model

The EMSI MR-SAM model relies on a number of internal and external data sources, mostly compiled by the federal government. What follows is a listing and short explanation of our sources. The use of these data will be covered in more detail later in this appendix.

EMSI Data are produced from many data sources to produce detailed industry, occupation, and demographic jobs and earnings data at the local level. This information (especially sales-to-jobs ratios derived from jobs and earnings-to-sales ratios) is used to help regionalize the national matrices as well as to disaggregate them into more detailed industries than are normally available.

BEA Make and Use Tables (MUT) are the basis for input-output models in the U.S. The *make* table is a matrix that describes the amount of each commodity made by each industry in a given year. Industries are placed in the rows and commodities in the columns. The *use* table is a matrix that describes the amount of each commodity used by each industry in a given year. In the use table, commodities are placed in the rows and industries in the columns. The BEA produces two different sets of MUTs, the benchmark and the summary. The benchmark set contains about 500 sectors and is released every five years, with a five-year lag time (e.g., 2002 benchmark MUTs were released in 2007). The summary set contains about 80 sectors and is released every year, with a two-year lag (e.g., 2010 summary MUTs were released in late 2011/early 2012). The MUTs are used in the EMSI SAM model to produce an industry-by-industry matrix describing all industry purchases from all industries.

BEA Gross Domestic Product by State (GSP) describes gross domestic product from the value added perspective. Value added is equal to employee compensation, gross operating surplus, and taxes on production and imports, less subsidies. Each of these components is reported for each state and an aggregate group of industries. This dataset is updated once per year, with a one-year lag. The EMSI SAM model makes use of this data as a control and pegs certain pieces of the model to values from this dataset.

BEA National Income and Product Accounts (NIPA) cover a wide variety of economic measures for the nation, including gross domestic product (GDP), sources of output, and distribution of income. This dataset is updated periodically throughout the year and can be between a month and several years old depending on the specific account. NIPA data are used in many of the EMSI MR-SAM processes as both controls and seeds.

BEA Local Area Income (LPI) encapsulates multiple tables with geographies down to the county level. The following two tables are specifically used: CA05 (Personal income and earnings by industry) and CA91 (Gross flow of earnings). CA91 is used when creating the commuting submodel and CA05 is used in several processes to help with place-of-work and place-of-residence differences, as well as to calculate personal income, transfers, dividends, interest, and rent.

BLS Consumer Expenditure Survey (CEX) reports on the buying habits of consumers along with some information as to their income, consumer unit, and demographics. EMSI utilizes this data heavily in the creation of the national demographic by income type consumption on industries.

Census of Government's (CoG) state and local government finance dataset is used specifically to aid breaking out state and local data that is reported in the MUTs. This allows EMSI to have unique production functions for each of its state and local government sectors.

Census' OnTheMap (OTM) is a collection of three datasets for the census block level for multiple years. **Origin-Destination** (OD) offers job totals associated with both home census blocks and a work census block. **Residence Area Characteristics** (RAC) offers jobs totaled by home census block. **Workplace Area Characteristics** (WAC) offers jobs totaled by work census block. All three of these are used in the commuting submodel to gain better estimates of earnings by industry that may be counted as commuting. This dataset has holes for specific years and regions. These holes are filled with Census' Journey-to-Work described later.

Census' Current Population Survey (CPS) is used as the basis for the demographic breakout data of the MR-SAM model. This set is used to estimate the ratios of demographic cohorts and their income for the three different income categories (i.e., wages, property income, and transfers).

Census' Journey-to-Work (JtW) is part of the 2000 Census and describes the amount of commuting jobs between counties. This set is used to fill in the areas where OTM does not have data.

Census' American Community Survey (ACS) **Public Use Microdata Sample** (PUMS) is the replacement for Census' long form and is used by EMSI to fill the holes in the CPS data.

Oak Ridge National Lab (ORNL) County-to-County Distance Matrix (Skim Tree) contains a matrix of distances and network impedances between each county via various modes of transportation such as highway, railroad, water, and combined highway-rail. Also included in this set are minimum impedances utilizing the best combination of paths. The ORNL distance matrix is used in EMSI's gravitational flows model that estimates the amount of trade between counties in the country.

A3.2 Overview of the MR-SAM model

EMSI's multi-regional social accounting matrix (MR-SAM) modeling system is a "comparative static" type model in the same general class as RIMS II (Bureau of Economic Analysis) and IMPLAN (Minnesota Implan Group). The MR-SAM model is thus not an "econometric" type model, the primary example of which is PolicyInsight by REMI. It relies on a matrix representation of industry-to-industry purchasing patterns originally based on national data which are regionalized with the use of local data and mathematical manipulation (i.e., non-survey methods). Models of this type estimate the ripple effects of changes in jobs, earnings, or sales in one or more industries upon other industries in a region.

The EMSI SAM model shows final equilibrium impacts – that is, the user enters a change that perturbs the economy and the model shows the changes required to establish a new equilibrium. As such, it is not a "dynamic" type model that shows year-by-year changes over time (as REMI's does).

A3.2.1 National SAM

Following standard practice, the SAM model appears as a square matrix, with each row sum exactly equaling the corresponding column sum. Reflecting its kinship with the standard Leontief input-output framework, individual SAM elements show accounting flows between row and column sectors during a chosen base year. Read across rows, SAM entries show the flow of funds into column accounts (a.k.a., "receipts" or "the appropriation of funds" by those column accounts). Read down columns, SAM entries show the flow of funds into row accounts (a.k.a., "expenditures" or "the dispersal of funds" to those row accounts).

The SAM may be broken into three different aggregation layers: broad accounts, sub-accounts, and detailed accounts. The broad layer is the most aggregate and will be covered first. Broad accounts cover between one and four sub-accounts, which in turn cover many detailed accounts. This appendix will not discuss detailed accounts directly because of their number. For example, in the industry broad account, there are two sub-accounts and over 1,100 detailed accounts.

A3.2.2 Multi-regional aspect of the SAM

Multi-regional (MR) describes a non-survey model that has the ability to analyze the transactions and ripple effects (i.e., multipliers) of not just a single region, but multiple regions interacting with each other. Regions in this case are made up counties across the entire United States.

EMSI's multi-regional model is built off of gravitational flows, assuming that the larger a county's economy, the more influence it will have on the surrounding counties' purchases and sales. The equation behind this model is essentially the same that Isaac Newton used to calculate the gravitational pull between planets and stars. In Newton's equation, the masses of both objects are multiplied, then divided by the distance separating them and multiplied by a constant. In EMSI's model, the masses are replaced with the supply of a sector for one county and the demand for that same sector from another county. The distance is replaced with an impedance value that takes into account the distance, type of roads, rail lines, and other modes of transportation. Once this is calculated for every county-to-county pair, a set of mathematical operations is performed to make sure all counties absorb the correct amount of supply from every county and the correct amount of demand from every county. These operations produce more than 200 million data points.

With the flows finalized, EMSI is able to use industry standard equations to adjust the national SAM and bring it into focus for the given region or regions. If the model being created is multi-regional, the amount and kind of transactions that occur between those regions is also calculated.

A3.3 Components of the EMSI SAM model

The EMSI MR-SAM is built from a number of different components that are gathered together to display information whenever a user selects a region. What follows is a description of each of these components and how each is created. EMSI's internally created data are used to a great extent throughout the processes described below, but its creation is not described in this appendix.

A3.3.1 County earnings distribution matrix

The county earnings distribution matrices describe the earnings spent by every industry on every occupation for a year – i.e., earnings by occupation. The matrices are built utilizing EMSI's industry earnings, occupational average earnings, and staffing patterns.

Each matrix starts with a region's staffing pattern matrix which is multiplied by the industry jobs vector. This produces the number of occupational jobs in each industry for the region. Next, the occupational average hourly earnings per job is multiplied by 2,080 hours, which converts the average hourly earnings into a yearly estimate. Then the matrix of occupational jobs is multiplied by the occupational annual earnings per job, converting it into earnings values. Last, all earnings are adjusted to match the known industry totals. This is a fairly simple process, but one that is very important. These matrices describe the place-of-work earnings used by the MR-SAM.

A3.3.2 Commuting model

The commuting sub-model is an integral part of EMSI's MR-SAM model. It allows the regional and multi-regional models to know what amount of the earnings can be attributed to place-of-residence vs. place-of-work. The commuting data describe the flow of earnings from any county to any other county (including within the counties themselves). For this situation, the commuted earnings are not just a single value describing total earnings flows over a complete year, but are broken out by occupation and demographic. Breaking out the earnings allows for analysis of place-of-residence (PoR) and place-of-work (PoW) earnings. These data are created using BLS's OnTheMap dataset, Census' Journey-to-Work, BEA's LPI CA91 and CA05 tables, and some of EMSI's data. The process incorporates the cleanup and disaggregation of the OnTheMap data, the estimation of a closed system of county inflows and outflows of earnings, and the creation of finalized commuting data.

A3.3.3 National SAM

The national SAM as described above is made up of several different components. Many of the elements already discussed are filled in with values from the national Z or transactions matrix. This matrix is built from BEA data that describe which industries make and use what commodities at the national level. These data are manipulated with some industry standard equations to produce the national Z matrix. The data in the Z matrix act as the basis for the majority of the data in the national SAM. The rest of the values are filled in with data from the county earnings distribution matrices, the commuting data, and the BEA's National Income and Product Accounts (NIPA).

One of the major issues that affect any SAM project is the combination of data from multiple sources that may not be consistent with one another. Matrix balancing is the broad name for the techniques used to correct this problem. EMSI uses a modification of the "diagonal similarity scaling" algorithm to balance the national SAM.

A3.3.4 Gravitational flows model

The most important piece of the EMSI MR-SAM model is the gravitational flows model that produces county sales, county subsidies, and county-by-county regional purchasing coefficients (RPCs). County sales are the vector of total output for every sector in the SAM applied to a given county. County subsidies are an estimation of the governmental subsidies given to specific industries in a given county. RPCs estimate how much an industry purchases from other industries inside and outside of the defined region. This information is critical for calculating regional economic SAM and IO models. As discussed earlier, the national SAM incorporates data from the national Z matrix, so from this point on, the national SAM will be referred to as the national Z SAM.

Before we explain how EMSI creates RPCs, one more concept must be introduced, namely the A matrix. An A matrix is mathematically derived from a Z matrix and shows the production function for each sector (i.e., what a sector requires from all other sectors in order to maintain its output). The matrix is calculated by normalizing the columns of a Z matrix with respect to the sales for that column. In other words, each column is scaled so that it sums to 1.

Table A3.1 shows a sample A matrix. Each cell value represents the percentage of a column industry's output that goes toward purchasing inputs from each row industry. So the cell containing 5 percent shows that Industry 2 spends 5 percent of its total output to obtain inputs from Industry 1.

Table A3.1: Sample "A" Matrix

	Industry 1	Industry 2	…	Industry n
Industry 1	1%	5%	…	3%
Industry 2	20%	0%	…	12%
…	…	…	…	…
Industry n	3%	9%	…	2%

When calculating RPCs, EMSI uses two methods:

Supply/demand pool method: This method uses regional industry presence and the national A matrix to estimate the regional industry demand that remains unmet by regional industry supply. The difference is assumed to be imported or exported, which defines the basis for all RPC calculation methods.

Gravitational flows method: This is a far more complex method for estimating RPCs, but it yields multi-regional data. Gravity modeling starts with the creation of an impedance matrix that values the difficulty of moving a product from county to county. Next, the impedance matrix is converted into a base matrix that contains seeds of multi-regional flows between counties in a given sector. This base matrix is then fed to a bi-proportional with supply and demand as the row and column constraints, respectively. The result is an estimate of multi-regional flows from every county to every county. These flows are divided by each respective county's demand to produce multi-regional RPCs.

A3.4 Model usages

The previous sections described the components of the EMSI SAM model and the data used to create regional and multi-regional models. This section describes how we use the data to create the models, beginning with a discussion of regional models and moving on to a less comprehensive overview of multi-regional models (multi-regional models are essentially the same as regional models but with additional information).

A3.4.1 Regional models

Regional models are simply county or ZIP code models that we aggregate together. Because the aggregated data would fill approximately 3,000 terabytes, we keep the models to a manageable size by constructing them using only the national SAM, county-by-county RPCs, county sales, county subsidies, county earnings distribution matrices, and the commuting data. For ZIP code models, we use county models as a basis and then scale them to the correct size.

A3.4.2 Multi-regional models

A multi-regional model is able to look at trade between several different county regions. It works by creating a very large matrix with each region's model in the diagonal and inter-region trade matrices in the off-diagonals. These off-diagonal matrices are created in a similar way to the regional county matrices. The major differences are the number of zeros in the matrix and which RPCs are used. Flows between regions are only accounted for within industries (calculated with RPCs) and residence adjustment earnings (from the commuting model).

A3.4.3 Using the model

There are a large number of uses for regional and multi-regional SAM models. Some examples of model usages are the following:

1. Multiplier effects: Estimate the jobs/earnings effects on industries and demographics due to an initial set of changes in one or more industries.
2. Regional requirements: Estimate the amount of industry requirements (goods/services purchased by the industry) that are obtained within a region versus those imported.
3. Regional exports: Estimate the amount that each industry exports from a region (exporting industries drive regional economic growth).
4. Gross Regional Product: GRP, similar to a nation's GDP, can be estimated for any region from the MR-SAM model.

Appendix 4: Value per Credit Hour Equivalent and the Mincer Function

Two key components in determining the economic impact and return on investment of education are 1) the value of the students' educational achievements, and 2) the change in that value over the students' working careers. Both of these components are described in detail in this appendix.

A4.1 Value per CHE

Typically the educational achievements of students are marked by the credentials they earn. However, not all students who attended TCUs in the 2013-14 analysis year obtained a degree or certificate. Some returned the following year to complete their education goals, while others took a few courses and entered the workforce without graduating. As such, the only way to measure the value of the students' achievement is through their credit hour equivalents, or CHEs. This approach allows us to see the benefits to all students who attended TCUs, not just those who earned a credential.

To calculate the value per CHE, we first determine how many CHEs are required to complete each education level. For example, assuming that there are 30 CHEs in an academic year, a student generally completes 60 CHEs in order to move from a high school diploma to an associate's degree, another 60 CHEs to move from an associate's degree to a bachelor's degree, and so on. This progression of CHEs generates an education ladder beginning at the less than high school level and ending with the completion of a doctoral degree, with each level education representing a separate stage in the progression.

The second step is to assign a unique value to the CHEs in the education ladder based on the wage differentials presented in Table 1.7. For example, the difference in earnings between a high school diploma and an associate's degree is $10,400. We spread this $10,400 wage differential across the 60 CHEs that occur between the high school diploma and the associate's degree, applying a ceremonial "boost" to the last CHE in the stage to mark the achievement of the degree.[34] We repeat this process for each education level in the ladder.

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." Research by Card (1999) indicates that the upper limit benefits defined by

[34] Economic theory holds that workers that acquire education credentials send a signal to employers about their ability level. This phenomenon is commonly known as the "sheepskin" or "signaling" effect. The ceremonial boosts applied to the achievement of degrees in the EMSI impact model are derived from David Jaeger and Marianne Page, "Degrees Matter: New Evidence on Sheepskin Effects in the Returns to Education," *Review of Economics and Statistics* 78, no. 4 (November 1996): 733-740.

correlation should be discounted by 10 percent.[35] As such, we reduce the marginal differences between education levels by 10 percent.

Next we map the CHE production of TCU 2013-14 student population to the education ladder. Table 1.4 provides information on the CHE production of TCU students broken out by educational achievement. In total, students completed 349,576 CHEs during the analysis year, excluding the CHE production of personal enrichment students. We map each of these CHEs to the education ladder depending on the students' education level and the average number of CHEs they completed during the year. For example, associate's degree graduates are allocated to the stage between the high school diploma and the associate's degree, and the average number of CHEs they completed informs the shape of the distribution curve used to spread out their total CHE production within that stage of the progression.

The sum product of the CHEs earned at each step within the education ladder and their corresponding value yields the students' aggregate annual increase in income (ΔE), as shown in the following equation:

$$\Delta E = \sum_{i=1}^{n} e_i h_i \text{ where } i \in 1, 2, \ldots n$$

and n is the number of steps in the education ladder, e_i is the marginal earnings gain at step i, and h_i is the number of CHEs completed at step i.

Table A4.1 displays the result for the students' aggregate annual increase in income (ΔE), a total of $61.2 million. By dividing this value by the students' total production of 349,576 CHEs during the analysis year, we derive an overall average value of $175 per CHE.

Table A4.1: Aggregate annual increase in income of TCUs students and average value per CHE

Aggregate annual increase in income	$61,245,676
Total credit hour equivalents (CHEs) in AY 2012-13*	349,576
Average value per CHE	$175

* Excludes the CHE production of personal enrichment students.
Source: EMSI impact model.

A4.2 Mincer Function

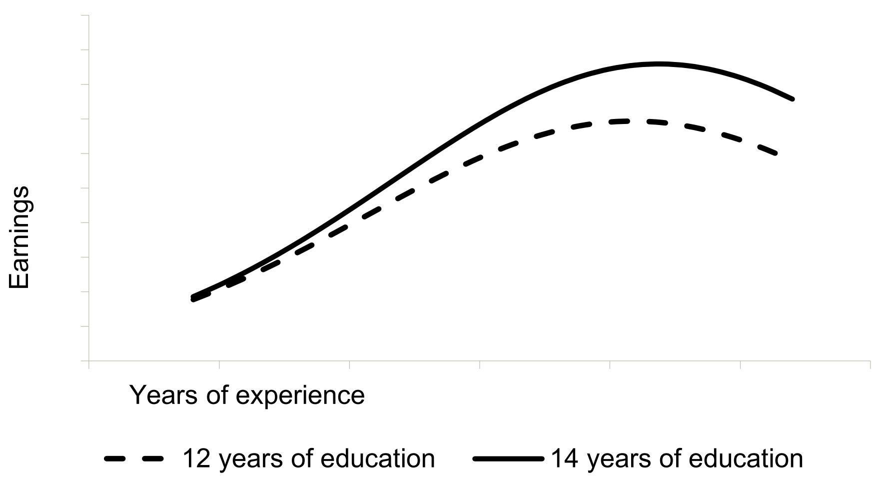
The $175 value per CHE in Table A4.1 only tells part of the story, however. Human capital theory holds that earnings levels do not remain constant; rather, they start relatively low and gradually increase as the worker gains more experience. Research also shows that the earnings increment between

[35] David Card, "The causal effect of education on earnings," *Handbook of Labor Economics* 3 (1999): 1801-1863. Card acknowledges that ability is unobservable and the instrumental variable techniques for measuring the ability bias are different. He concludes that the "best available" evidence suggests a "small upward bias (on the order of 10%)."

educated and non-educated workers grows through time. These basic patterns in earnings over time were originally identified by Jacob Mincer, who viewed the lifecycle earnings distribution as a function with the key elements being earnings, years of education, and work experience, with age serving as a proxy for experience.[36] Mincer's earnings function is still upheld in recent data and has served as the foundation for a variety of research pertaining to labor economics.

Figure A4.1 illustrates several important points about the Mincer function. First, as demonstrated by the shape of the curves, an individual's earnings initially increase at an increasing rate, then increase at a decreasing rate, reach a maximum somewhere well after the midpoint of the working career, and then decline in later years. Second, individuals with higher levels of education reach their maximum earnings at an older age compared to individuals with lower levels of education (recall that age serves as a proxy for years of experience). And third, the benefits of education, as measured by the difference in earnings between education levels, increase with age.

Figure A4.1: Lifecycle change in earnings, 12 years versus 14 years of education



In calculating the alumni impact in Chapter 2, we use the slope of the curve in Mincer's earnings function to condition the $175 value per CHE to the students' age and work experience.[37] To the students just starting their career during the analysis year, we apply a lower value per CHE; to the

[36] See Mincer, 1958 and Jacob Mincer, "Schooling, Experience and Earnings" (New York: National Bureau of Economic Research, 1974). See also Gary S. Becker, *Human Capital: a Theoretical Analysis with Specific Reference to Education* (New York: Columbia College Press for NBER, 1964).

[37] 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.

students in the latter half or approaching the end of their careers we apply a higher value per CHE. The original $175 value per CHE applies only to the CHE production of students precisely at the midpoint of their careers during the analysis year.

In Chapter 3 we again apply the Mincer function, this time to project the benefits stream of the TCU 2013-14 student population into the future. Here too the value per CHE is lower for students at the start of their career and higher near the end of it, in accordance with the scalars derived from the slope of the Mincer curve illustrated in Figure A4.1.

A4.3 Conclusion

This appendix demonstrates the significance of the value per CHE and the Mincer function in determining the initial effect of alumni on the national economy in Chapter 2 and the students' return on their educational investment in Chapter 3. Both chapters provide further discussion on the role that the students' CHE production and corresponding increase in earnings play in calculating the study outcomes.

Appendix 5: Alternative Education Variable

In a scenario where TCUs do not exist, some of their students would still be able to avail themselves of an alternative comparable education. These students create benefits in the U.S. even in the absence of the TCUs. The alternative education variable accounts for these students and is used to discount the benefits we attribute to TCUs.

Recall this analysis considers only relevant economic information regarding TCUs. Considering the existence of various other academic institutions surrounding each TCUs, we have to assume that a portion of the students could find alternative educations. For example, some students may participate in online programs. For these students – who would have found an alternative education and produced benefits in the U.S. regardless of the presence of TCUs – we discount the benefits attributed to the TCUs.

In the absence of TCUs, we assume 15 percent of students attending TCUs would find alternative education opportunities and remain in or return to the U.S. We account for this by discounting the alumni impact, the benefits to taxpayers, and the benefits to society in the U.S. in sections 3 and 4 by 15 percent. In other words, we assume 15 percent of the benefits created by TCU students would have occurred anyways in the counterfactual scenario where the TCUs did not exist. A sensitivity analysis of this adjustment is presented in chapter 4.

Appendix 6: Overview of Investment Analysis Measures

The purpose of this appendix is to provide context to the investment analysis results using the simple hypothetical example summarized in Table A6.1 below. The table shows the projected benefits and costs for a single student over time and associated investment analysis results.[38]

Table A6.1: Example of the benefits and costs of education for a single student

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			**$21,500**	**$35,753**	**$14,253**
Internal rate of return					**18.0%**
Benefit-cost ratio					**1.7**
Payback period					**4.2 years**

Assumptions are as follows:

1. Benefits and costs are projected out ten years into the future (Column 1).
2. The student attends college for one year, and the cost of tuition is $1,500 (Column 2).
3. Earnings forgone while attending college for one year (opportunity cost) come to $20,000 (Column 3).
4. Together, tuition and earnings forgone cost sum to $21,500. This represents the out-of-pocket investment made by the student (Column 4).
5. In return, the student earns $5,000 more per year than he would have otherwise earned without the education (Column 5).
6. The net cash flow (NCF) in Column 6 shows higher earnings (Column 5) less the total cost (Column 4).

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

7. The assumed "going rate" of interest is 4 percent, 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, the internal rate of return, the benefit-cost ratio, and the payback period. Each of these is briefly explained below in the context of the cash flow numbers presented in Table A6.1.

A6.1 Net present value

The student in Table A6.1 can choose either to attend college or to forgo post-secondary education and maintain his present employment. If he decides to enroll, certain economic implications unfold. Tuition and fees must be paid, and earnings will cease for one year. In exchange, the student calculates that with post-secondary education, his 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 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 (tuition plus earnings forgone) are felt immediately because they are incurred today, in the present. Benefits, 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.[39]

Let us take a brief example. At 4 percent, 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 percent 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 percent. 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 (in this example, tuition plus earnings forgone). As indicated in Table A6.1, the cumulative present value of $5,000 worth of higher earnings between years 2 and 10 is $35,753 given the 4 percent interest rate, far lower than the undiscounted $45,000 discussed above.

[39] 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.

The net present value of the investment is $14,253. This is simply the present value of the benefits less the present value of the costs, or $35,753 - $21,500 = $14,253. In other words, the present value of benefits exceeds the present value of costs by as much as $14,253. 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.

A6.2 Internal rate of return

The internal rate of return is another way of measuring the worth of investing in education using the same cash flows shown in Table A6.1. 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 discussion of the net present value above, the model applies the "going rate" of interest of 4 percent and computes a positive net present value of $14,253. 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 percent in fact, as indicated in Table A6.1. Or, if a discount rate of 18.0 percent were applied to the net present value calculations instead of the 4 percent, then the net present value would reduce to zero.

What does this mean? The internal rate of return of 18.0 percent 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 percent, 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 percent 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 percent "going rate" of interest applied to the net present value calculations, 18.0 percent is far higher than 4 percent. It may be concluded, therefore, that the investment in this case is solid. Alternatively, comparing the 18.0 percent rate of return to the long-term 7 percent 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 approach for calculating the internal rate of return can sometimes generate wild or unbelievable results that defy the imagination. Technically, the approach requires at least one negative cash flow to offset all subsequent positive flows. For example, if the student works full-time while attending college, the opportunity cost of time would be much lower. The only out-of-pocket cost would be the $1,500 paid for tuition. In this case, it would still be possible to compute the internal rate of return, but it would be a staggering 333 percent because only a negative $1,500 cash flow would be offsetting nine subsequent years of $5,000 worth of higher earnings. Although the 333 percent return would technically be correct, it would not be consistent with the conventional understanding of returns expressed as percentages.

A6.3 Benefit-cost ratio

The benefit-cost ratio is simply the present value of benefits divided by present value of costs, or \$35,753 ÷ \$21,500 = 1.7 (based on the 4 percent discount rate). Of course, any change in the discount rate would also change the benefit-cost ratio. Applying the 18.0 percent internal rate of return discussed above would reduce the benefit-cost ratio to 1.0, the breakeven solution where benefits just equal costs. Applying a discount rate higher than the 18.0 percent 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.

A6.4 Payback period

This is the length of time from the beginning of the investment (consisting of tuition and earnings forgone) until higher future earnings give a return on the investment made. For the student in Table A6.1, it will take roughly 4.2 years of \$5,000 worth of higher earnings to recapture his investment of \$1,500 in tuition and the \$20,000 in earnings forgone while attending college. Higher earnings that occur 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: Social Externalities

Education has a predictable and positive effect on a diverse array of social benefits. These, when quantified in dollar terms, represent significant social savings that directly benefit society as a 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 welfare and unemployment.

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.

A7.1 Health

Statistics clearly show the correlation between increases in education and improved health. The manifestations of this are found in five health-related variables: smoking, alcoholism, obesity, mental illness, and drug abuse. There are 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 between them.

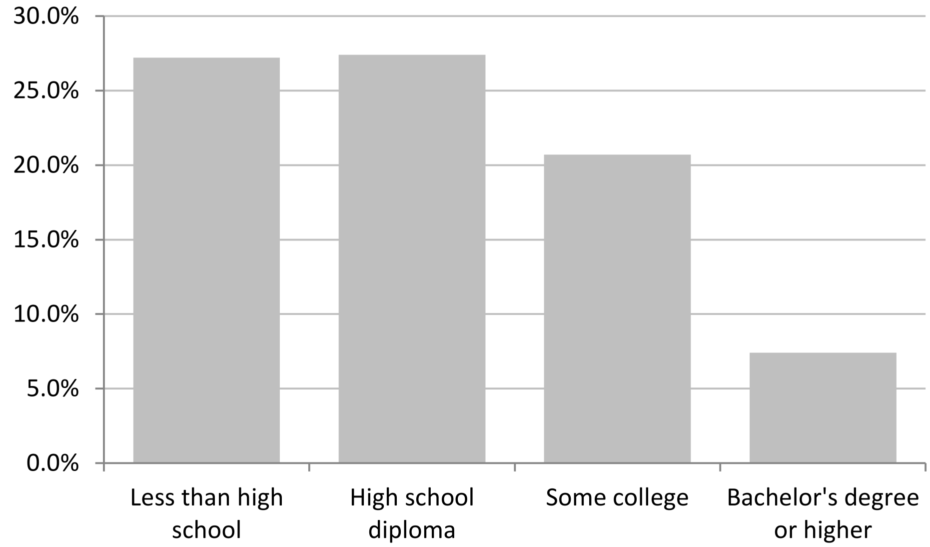
A7.1.1 Smoking

Despite a marked decline over the last several decades in the percentage of U.S. residents that smoke, a sizeable percentage of the U.S. population still uses 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 U.S.

Figure A7.1 shows the prevalence of cigarette smoking among adults aged 25 years and over, based on data provided by the National Health Interview Survey.[40] As indicated, the percent of persons who smoke begins to decline beyond the level of high school education.

[40] Centers for Disease Control and Prevention, "Table 61. Age-adjusted prevalence of current cigarette smoking among adults aged 25 and over, by sex, race, and education level: United States, selected years 1974-2011," National Health Interview Survey, 2011.

Figure A7.1: Prevalence of smoking among U.S. adults by education level



The Centers for Disease Control and Prevention (CDC) reports the percentage of adults who are current smokers by state.[41] We use this information to create an index value by which we adjust the national prevalence data on smoking to each state.

A7.1.2 Alcohol abuse

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 healthcare expenditures for treatment, prevention, and support; workplace losses due to reduced worker productivity; and other effects.

Figure A7.2 compares the percent of males and females aged 26 and older that abuse or depend on alcohol at the less than high school level to the prevalence rate of alcoholism among college graduates, based on data supplied by the Substance Abuse and Mental Health Services Administration (SAMHSA).[42] These statistics give an indication of the correlation between education and the reduced probability of alcoholism. As indicated, alcohol dependence or abuse falls from a 7.7 percent prevalence rate among males with less than a high school diploma to a 6.9 percent prevalence rate among males with a college degree. Similarly, alcohol dependence or abuse among females ranges

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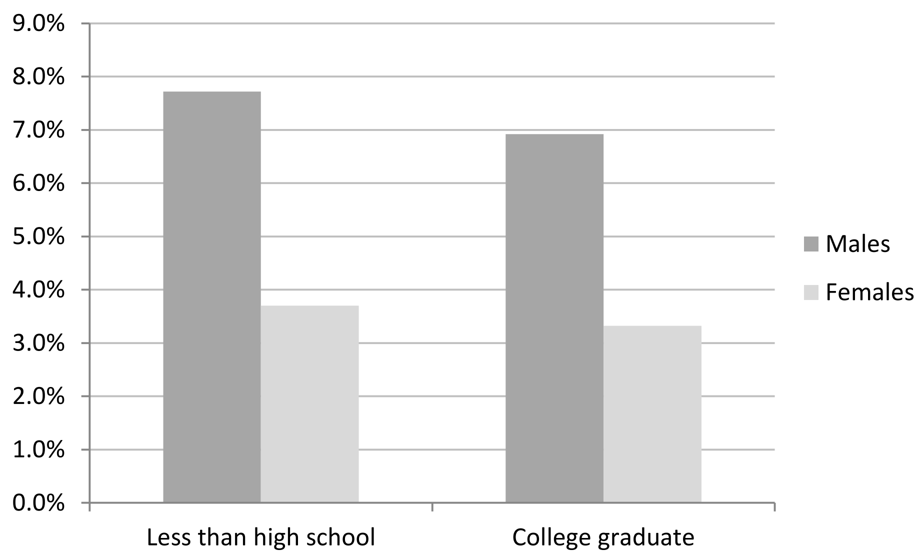
[41] Centers for Disease Control and Prevention, "Adults who are current smokers" in "Tobacco Use – 2011," Behavioral Risk Factor Surveillance System Prevalence and Trends Data, accessed August 2013, http://apps.nccd.cdc.gov/brfss/list.asp?cat=TU&yr=2011&qkey=8161&state=All.

[42] Substance Abuse and Mental Health Services Administration, "Table 5.7B - Substance Dependence or Abuse in the Past Year among Persons Aged 26 or Older, by Demographic Characteristics: Percentages, 2010 and 2011," Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2010 and 2011.

from a 3.7 percent prevalence rate at the less than high school level to a 3.3 percent prevalence rate at the college graduate level.

Figure A7.2: Prevalence of alcohol dependence or abuse by sex and education level



A7.1.3 Obesity

The rise in obesity and diet-related chronic diseases has led to increased attention on how expenditures relating to obesity have increased in recent years. The average cost of obesity-related medical conditions is calculated using information from the *Journal of Occupational and Environmental Medicine*, which reports incremental medical expenditures and productivity losses due to excess weight.[43] The CDC also reports the prevalence of obesity among adults by state.[44]

Data for Figure A7.3 was provided by the National Center for Health Statistics which shows the prevalence of obesity among adults aged 20 years and over by education and sex.[45] As indicated, college graduates are less likely to be obese than individuals with a high school diploma. However, the prevalence of obesity among males with some college is actually greater than males with no more than a high school diploma. In general, though, obesity tends to decline with increasing levels of education.

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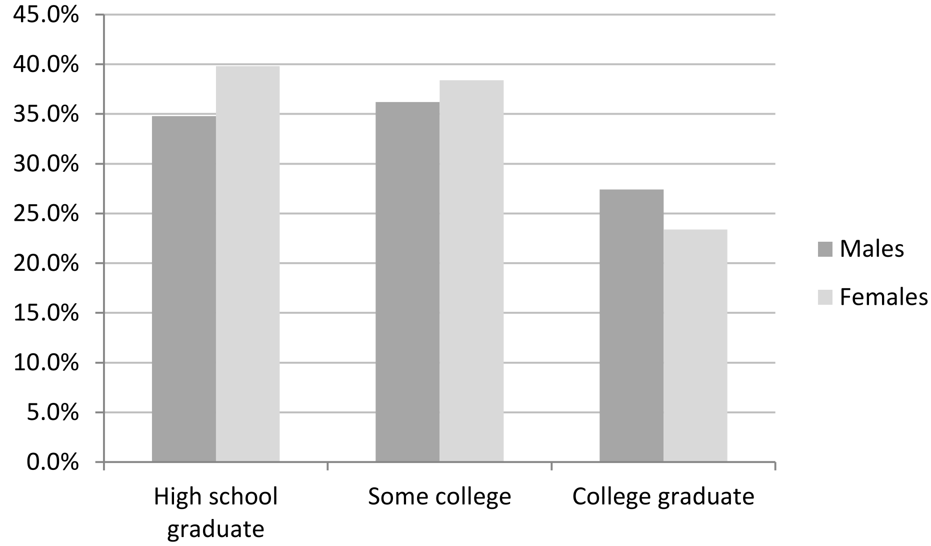
[43] Eric A. Finkelstein, Marco da Costa DiBonaventura, Somali M. Burgess, and Brent C. Hale, "The Costs of Obesity in the Workplace," *Journal of Occupational and Environmental Medicine* 52, no. 10 (October 2010): 971-976.

[44] Centers for Disease Control and Prevention, "Adult Obesity Facts," Overweight and Obesity, accessed August 2013, http://www.cdc.gov/obesity/data/adult.html#Prevalence.

[45] Cynthia L. Ogden, Molly M. Lamb, Margaret D. Carroll, and Katherine M. Flegal, "Figure 3. Prevalence of obesity among adults aged 20 years and over, by education, sex, and race and ethnicity: United States 2005-2008" in "Obesity and Socioeconomic Status in Adults: United States 2005-2008," NCHS data brief no. 50, Hyattsville, MD: National Center for Health Statistics, 2010.

Figure A7.3: Prevalence of obesity by education level

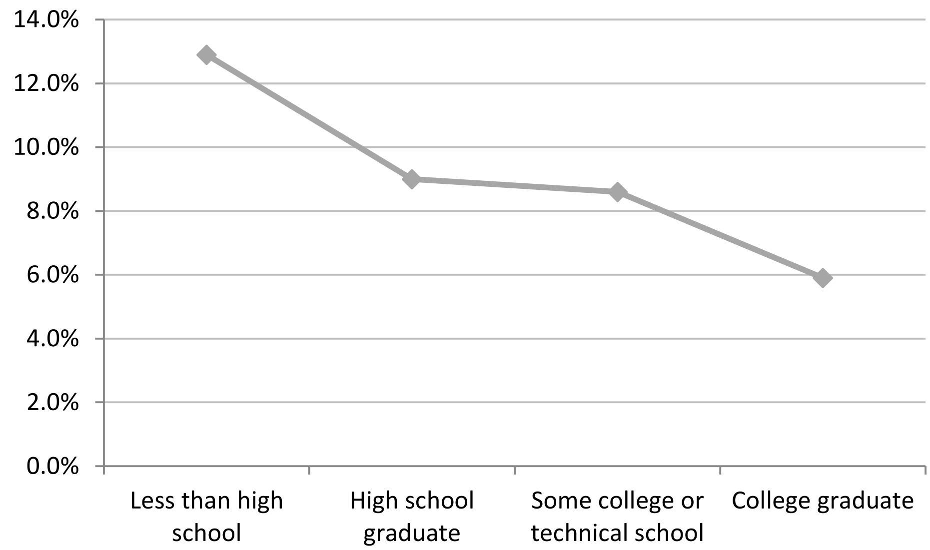


A7.1.4 Mental illness

Capturing the full economic cost of mental disorders is problematic because many of the costs are hidden or difficult to detach from others externalities, such as drug abuse or alcoholism. For this reason, this study only examines the costs of absenteeism caused by depression in the workplace. Figure A7.4 summarizes the prevalence of self-reported frequent mental distress among adults by education level, based on data supplied by the CDC.[46] As shown, people with higher levels of education are less likely to suffer from mental illness, with the prevalence of mental illness being the highest among people with less than a high school diploma.

[46] Centers for Disease Control and Prevention, "Table 1. Number of respondents to a question about mental health and percentage who self-reported frequent mental distress (FMD), by demographic characteristics -- United States, Behavioral Risk Factor Surveillance System, 1993-1996" in "Self-Reported Frequent Mental Distress Among Adults -- United States, 1993-1996." *Morbidity and Mortality Weekly Report* 47, no. 16 (May 1998): 325-331.

Figure A7.4: Prevalence of frequent mental distress by education level



A7.1.5 Drug abuse

The burden and cost of illicit drug abuse is enormous in our society, but little is known about potential costs and effects at a population level. What is known is that the rate of people abusing drugs is inversely proportional to their education level. The higher the education level, the less likely a person is to abuse or depend on illicit drugs. The probability that a person with less than a high school diploma will abuse drugs is 2.9 percent, nearly six times greater than the probability of drug abuse for college graduates (0.5 percent). This relationship is presented in Figure A7.5 based on data supplied by SAMHSA.[47] Health costs associated with illegal drug use are also available from SAMSHA, with costs to government representing 48 percent of the total cost related to illegal drug use.[48]

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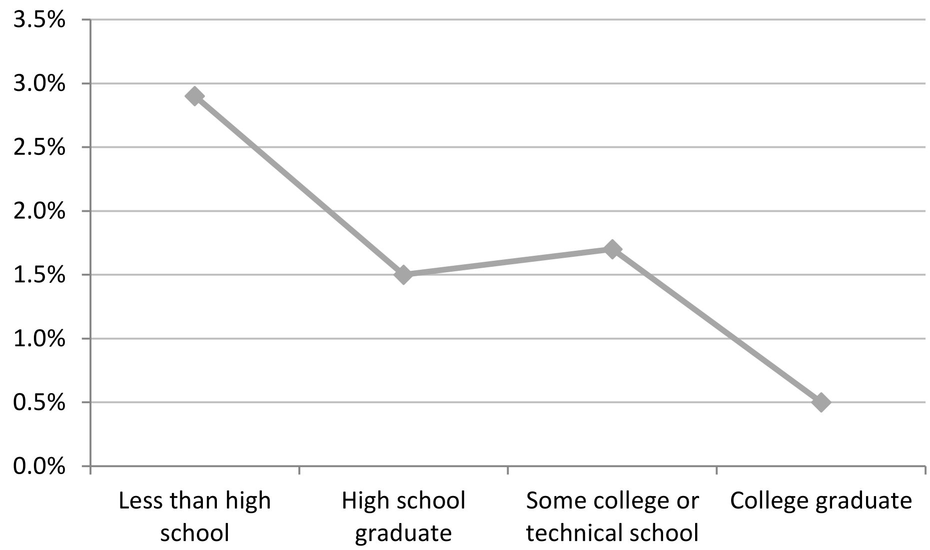
[47] Substance Abuse and Mental Health Services Administration, National Survey on Drug Use and Health, 2010 and 2011.
[48] Substance Abuse and Mental Health Services Administration. "Table A.2. Spending by Payer: Levels and Percent Distribution for Mental Health and Substance Abuse (MHSA), Mental Health (MH), Substance Abuse (SA), Alcohol Abuse (AA), Drug Abuse (DA), and All-Health, 2005" in *National Expenditures for Mental Health Services & Substance Abuse Treatment, 1986 – 2005*. DHHS Publication No. (SMA) 10-4612. Rockville, MD: Center for Mental Health Services and Center for Substance Abuse Treatment, Substance Abuse and Mental Health Services Administration, 2010.

Figure A7.5: Prevalence of illicit drug dependence or abuse by education level



A7.2 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) criminal justice expenditures, including police protection, judicial and legal, and corrections, 2) victim costs, and 3) productivity lost as a result of time spent in jail or prison rather than working.

Figure A7.6 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 federal, state, and local prisons as provided by the Bureau of Justice Statistics,[49] divided by the total adult population. As indicated, incarceration drops on a sliding scale as education levels rise.

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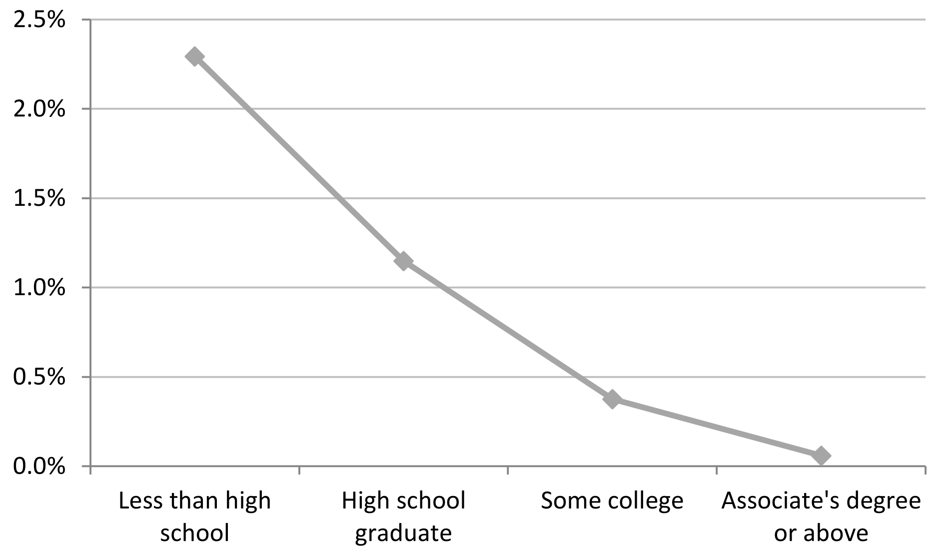
[49] Caroline Wolf Harlow. "Table 1. Educational attainment for State and Federal prison inmates, 1997 and 1991, local jail inmates, 1996 and 1989, probationers, 1995, and the general population, 1997" in "Education and Correctional Populations." Bureau of Justice Statistics Special Report, January 2003, NCJ 195670. Accessed August 2013. http://bjs.ojp.usdoj.gov/index.cfm?ty=pbdetail&iid=814.

Figure A7.6: 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 related to pain and suffering.[50]

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

A7.3 Welfare and unemployment

Statistics show that as education levels increase, the number of welfare and unemployment applicants declines. Welfare and unemployment claimants can receive assistance from a variety of different sources, including Temporary Assistance for Needy Families (TANF), Supplemental Nutrition Assistance Program (SNAP), Medicaid, Supplemental Security Income (SSI), and unemployment insurance.[51]

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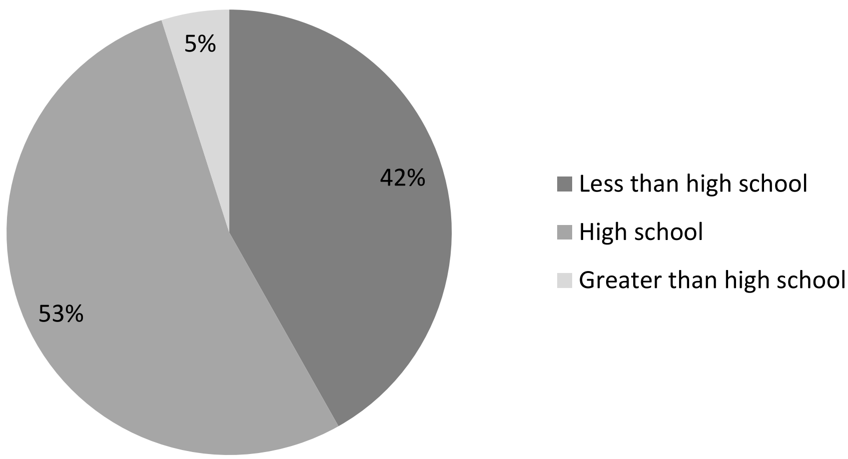
[50] Kathryn E. McCollister, Michael T. French, and Hai Fang, "The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation." *Drug and Alcohol Dependence* 108, no. 1-2 (April 1, 2010): 98-109.

[51] Medicaid is not considered in the analysis for welfare because it overlaps with the medical expenses in the analyses for smoking, alcoholism, obesity, mental illness, and drug abuse. We also exclude any welfare benefits associated with disability and age.

Figure A7.7 relates the breakdown of TANF recipients by education level, derived from data supplied by the U.S. Department of Health and Human Services.[52] As shown, the demographic characteristics of TANF recipients are weighted heavily towards the less than high school and high school categories, with a much smaller representation of individuals with greater than a high school education.

Figure A7.7: Breakdown of TANF recipients by education level

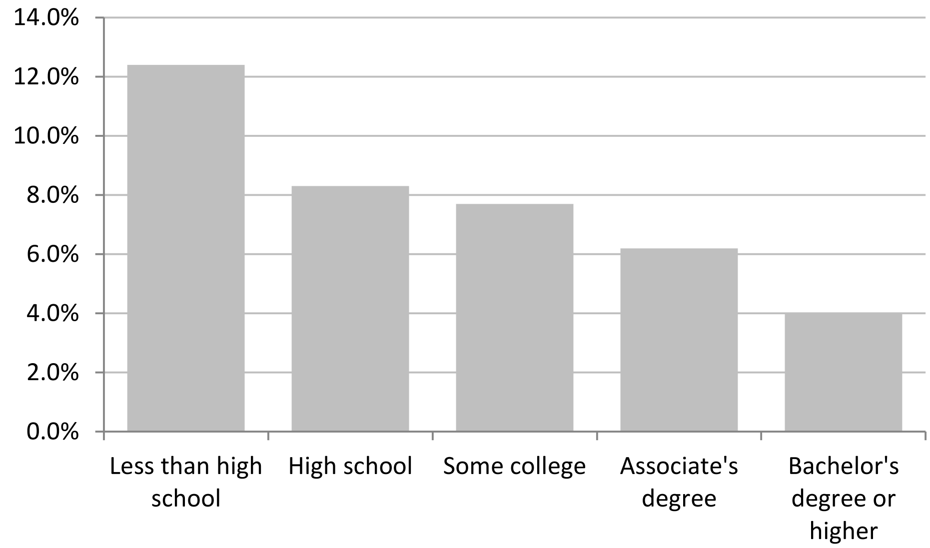


Unemployment rates also decline with increasing levels of education, as illustrated in Figure A7.8. These data are supplied by the Bureau of Labor Statistics.[53] As shown, unemployment rates range from 12.4 percent for those with less than a high school diploma to 4.0 percent for those at the bachelor's degree level or higher.

[52] U.S. Department of Health and Human Services, Office of Family Assistance, "Table 10:26 - Temporary Assistance for Needy Families - Active Cases: Percent Distribution of TANF Adult Recipients by Educational Level, AY 2009" in Temporary Assistance for Needy Families Program Ninth Report to Congress, 2012.

[53] Bureau of Labor Statistics, "Table 7. Employment status of the civilian noninstitutional population 25 years and over by educational attainment, sex, race, and Hispanic or Latino ethnicity." Current Population Survey, Labor Force Statistics. Accessed August 2013. http://www.bls.gov/cps/cpsaat07.pdf.

Figure A7.8: Unemployment by education level



A7.4 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 education.