ROANOKE-CHOWAN COMMUNITY COLLEGE

MAIN REPORT

JANUARY 2022

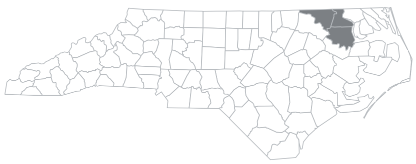
The Economic Value of Selected Individual Programs at Roanoke-Chowan Community College

Emsi | burningglass

CONTENTS

Executive summary

THIS REPORT ASSESSES the impact of three of Roanoke-Chowan Community College's (R-CCC) programs on the R-CCC Service Area[1] economy, the return on investment to the program's students, and the benefits generated for North Carolina taxpayers. Following are some of the key findings of this analysis.



THE R-CCC SERVICE AREA, NC

Industrial Systems and Mechatronics Engineering Technology

In FY 2019-20, R-CCC enrolled 22 students in its Industrial Systems and Mechatronics Engineering Technology program. Students who complete this program are expected to enter occupations such as electrical & electronic engineering technologists & technicians; electro-mechanical & mechatronics technologists & technicians; and finishers. In the R-CCC Service Area, the average number of annual job openings in these types of occupations in 2020 was two, and over the next 10 years the average number of jobs is expected to grow 0.5%. Comparing annual job openings to R-CCC Industrial Systems and Mechatronics Engineering Technology program students, there is a surplus of 20 students.[2] R-CCC's Industrial Systems and Mechatronics Engineering Technology program alumni generated an estimated $95 thousand in added income to the R-CCC Service Area economy in FY 2019-20. The undiscounted lifetime earnings increase per student is $618.3 thousand. For every dollar a student invests in their education in R-CCC's Industrial Systems and Mechatronics Engineering Technology program, they will receive $19.70 back over the course of their working lives. The corresponding internal rate of return is 29.2% for students in the Industrial Systems and Mechatronics Engineering Technology program. Finally, students aren't the only ones who receive benefits from completing the Industrial Systems and Mechatronics Engineering Technology program at R-CCC. North Carolina taxpayers will also receive benefits from R-CCC's Industrial Systems and Mechatronics Engineering Technology program students in the form of added tax revenues and government savings. In total, throughout the FY 2019-20 students' working lifetime, North Carolina taxpayers will receive $112.2 thousand in present value benefits.

Criminal Justice Technology

In FY 2019-20, R-CCC enrolled 13 students in its Criminal Justice Technology program. Students who complete this program are expected to enter occupations such as emergency management directors; police & sheriffs patrol officers; and compliance officers. In the R-CCC

1 For the purposes of this analysis, the R-CCC Service Area is defined as Hertford, Northampton, and Bertie Counties.

2 For the purposes of this analysis, only R-CCC students were considered when comparing to annual openings.

Service Area, the average number of annual job openings in these types of occupations in 2020 was 34, and over the next 10 years the average number of jobs is expected to grow 0.9%. Comparing annual job openings to R-CCC completers for the Criminal Justice Technology program, there is a gap of 33 job openings. R-CCC's Criminal Justice Technology program alumni generated an estimated $213.1 thousand in added income to the R-CCC Service Area economy in FY 2019-20. The undiscounted lifetime earnings increase per student is $318.3 thousand. For every dollar a student invests in their education in R-CCC's Criminal Justice Technology program, they will receive $7.70 back over the course of their working lives. The corresponding internal rate of return is 18.9% for students in the Criminal Justice Technology program. Finally, students aren't the only ones who receive benefits from completing the Criminal Justice Technology program at R-CCC. North Carolina taxpayers will also receive benefits from R-CCC's Criminal Justice Technology program students in the form of added tax revenues and government savings. In total, throughout the FY 2019-20 students' working lifetime, North Carolina taxpayers will receive $24 thousand in present value benefits.

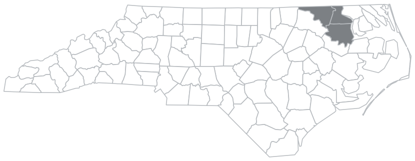
Early Childhood Education

In FY 2019-20, R-CCC enrolled 11 students in its Early Childhood Education program. Students who complete this program are expected to enter occupations such as preschool teachers, except special education; childcare workers; and counseling, & school psychologists. In the R-CCC Service Area, the average number of annual job openings in these types of occupations in 2020 was 25, and over the next 10 years the average number of jobs is expected to grow 0.8%. Comparing annual job openings to R-CCC completers for the Early Childhood Education program, there is a gap of 24 job openings. R-CCC's Early Childhood Education program alumni generated an estimated $166.7 thousand in added income to the R-CCC Service Area economy in FY 2019-20. The undiscounted lifetime earnings increase per student is $167.7 thousand. For every dollar a student invests in their education in R-CCC's Early Childhood Education program, they will receive $1.30 back over the course of their working lives. The corresponding internal rate of return is 6.3% for students in the Early Childhood Education program. Finally, students aren't the only ones who receive benefits from completing the Early Childhood Education program at R-CCC. North Carolina taxpayers will also receive benefits from R-CCC's Early Childhood Education program students in the form of added tax revenues and government savings. In total, throughout the FY 2019-20 students' working lifetime, North Carolina taxpayers will receive $7 thousand in present value benefits.

CHAPTER 1:

Introduction

ROANOKE-CHOWAN Community College's (R-CCC) region, for the purpose of this report, is referred to as the R-CCC Service Area and consists of Hertford, Northampton, and Bertie Counties.



THE R-CCC SERVICE AREA, NC

While R-CCC offers a variety of programs, this study is concerned with considering the economic impact and return on investment derived from the students of three of its programs. These programs include:

- Industrial Systems and Mechatronics Engineering Technology
- Criminal Justice Technology
- Early Childhood Education

The first component of this study analyzes the career outlook for each program. Each program maps to a number of occupations, which we use to measure the number of annual job openings available to completers of each program. Finally, we provide the median hourly wage and top companies hiring in the R-CCC Service Area.

The second component of the study measures the economic impact from the alumni of each program. While the programs each affect the region in a variety of ways, many of them difficult to quantify, this study is concerned with considering the economic benefits of their alumni. The programs are designed to help students achieve their individual potential and develop the knowledge, skills, and abilities they need to have fulfilling and prosperous careers. However, the value of R-CCC consists of more than simply influencing the lives of students. The college's program offerings supply employers with workers to make their businesses more productive. To derive results, we rely on a specialized Multi-Regional Social Accounting Matrix (MR-SAM) model to calculate the added income created in the R-CCC Service Area economy as a result of increased consumer spending and the added knowledge, skills, and abilities of students.

The third component of the study measures the benefits generated by students of the programs. We perform an investment analysis to determine how the money spent by the programs' students on their education performs as an investment over time. The students' investment in this case consists of their out-of-pocket expenses and their opportunity cost of attending the college as opposed to working. In return for these investments, students receive a lifetime of higher earnings.

The fourth component of the study measures the benefits generated by program students for North Carolina taxpayers. As FY 2019-20 students earn more because of the education they received at R-CCC, the tax base in North Carolina will also increase. In addition, savings will be generated to the public sector from reduced demand for government-funded social services in North Carolina.

The study uses a wide array of data that are based on several sources, including the programs' FY 2019-20 academic and student financial data from R-CCC; industry and employment data from the Bureau of Labor Statistics and Census Bureau; outputs of Emsi Burning Glass's impact model and MR-SAM model; and a variety of published materials relating education to social behavior.

Important note

When reviewing the impacts estimated in this study, it is important to note that the study reports impacts in the form of added income rather than sales. Sales includes all of the intermediary costs associated with producing goods and services, as well as money that leaks out of the county as it is spent at out-of-county businesses. Income, on the other hand, is a net measure that excludes these intermediary costs and leakages, and is synonymous with gross regional product (GRP) and value added. For this reason, it is a more meaningful measure of new economic activity than sales.

THE R-CCC SERVICE AREA ECONOMY

R-CCC serves a region referred to as the R-CCC Service Area in North Carolina.[3] Since the college was first established, it has been serving the R-CCC Service Area by enhancing the workforce, providing local residents with easy access to higher education opportunities and preparing students for highly skilled, technical professions. Table 1.1 summarizes the breakdown of the regional economy by major industrial sector ordered by total income, with details on labor and non-labor income. Labor income refers to wages, salaries, and proprietors' income. Non-labor income refers to profits, rents, and other forms of investment income. Together, labor and non-labor income comprise the region's total income, which can also be considered as the region's gross regional product (GRP). As shown in Table 1.1, the total income, or GRP, of the R-CCC Service Area is approximately $2 billion, equal to the sum of labor income ($1.2 billion) and non-labor income ($849.7 million).

Table 1.1: INCOME BY MAJOR INDUSTRY SECTOR IN THE R-CCC SERVICE AREA, 2020*

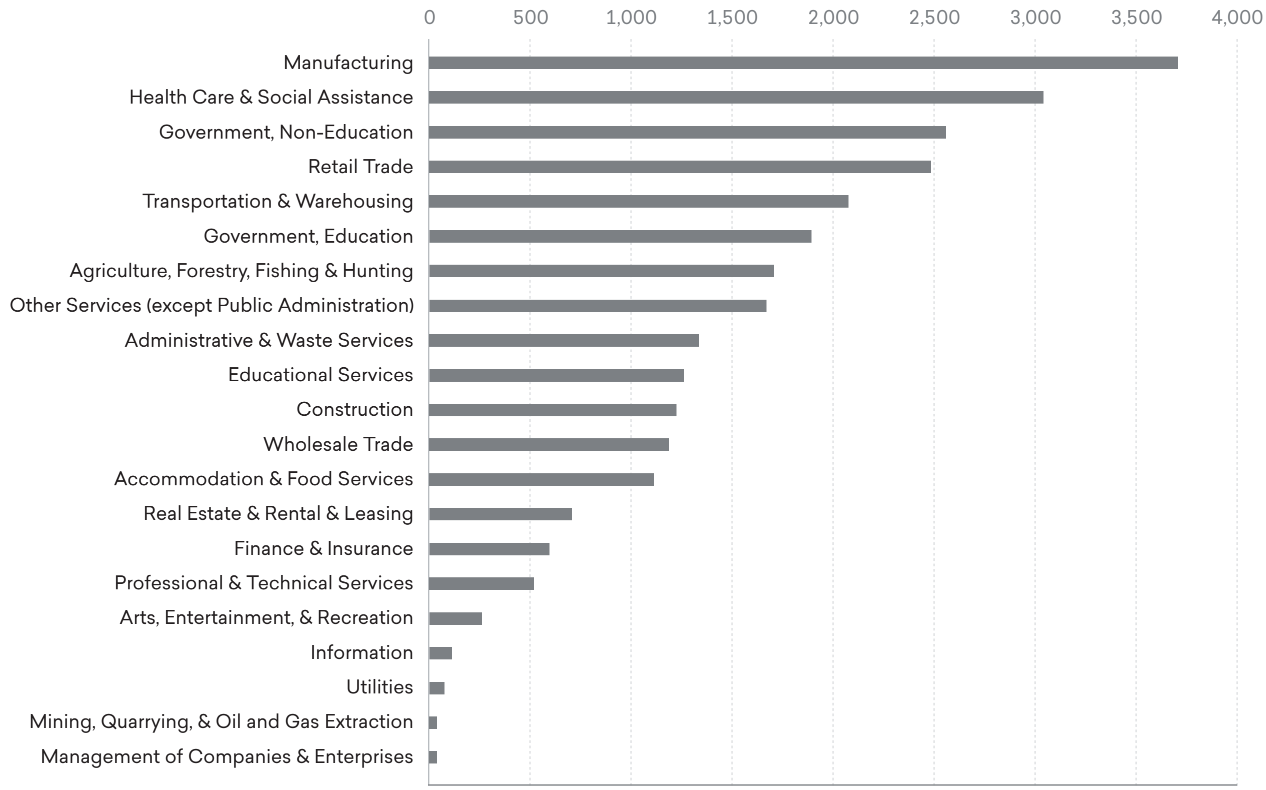
Industry sector	Labor income (millions)	Non-labor income (millions)	Total income (millions)**	% of total income	Sales (millions)
Manufacturing	$217	$330	$547	27%	$1,917
Other Services (except Public Administration)	$34	$216	$250	12%	$361
Government, Non-Education	$151	$28	$179	9%	$948
Wholesale Trade	$73	$81	$155	8%	$265
Transportation & Warehousing	$94	$29	$124	6%	$236
Health Care & Social Assistance	$102	$17	$119	6%	$179
Retail Trade	$69	$50	$118	6%	$207
Government, Education	$102	$0	$102	5%	$117
Construction	$59	$13	$71	4%	$134
Administrative & Waste Services	$48	$15	$63	3%	$123
Educational Services	$49	$10	$59	3%	$79
Agriculture, Forestry, Fishing & Hunting	$69	-$14	$55	3%	$248
Finance & Insurance	$28	$24	$52	3%	$89
Utilities	$9	$28	$37	2%	$55
Real Estate & Rental & Leasing	$29	$2	$31	2%	$96
Accommodation & Food Services	$18	$9	$28	1%	$54
Professional & Technical Services	$17	$5	$22	1%	$32
Information	$3	$5	$7	<1%	$12
Arts, Entertainment, & Recreation	$5	$1	$6	<1%	$10
Mining, Quarrying, & Oil and Gas Extraction	$1	$1	$2	<1%	$4
Management of Companies & Enterprises	$1	$0	$1	<1%	$1
Total	**$1,178**	**$850**	**$2,027**	**100%**	**$5,167**

* Data reflect the most recent year for which data are available. Emsi Burning Glass data are updated quarterly.
** Numbers may not add due to rounding.
Source: Emsi Burning Glass industry data.

3 The following counties comprise the R-CCC Service Area: Hertford, Northampton, and Bertie.

Figure 1.1 provides the breakdown of jobs by industry in the R-CCC Service Area. The Manufacturing sector is the largest employer, supporting 3,713 jobs or 13.5% of total employment in the region. The second largest employer is the Health Care & Social Assistance sector, supporting 3,027 jobs or 11.0% of the region's total employment. Altogether, the region supports 27,531 jobs.[4]

Figure 1.1: JOBS BY MAJOR INDUSTRY SECTOR IN THE R-CCC SERVICE AREA, 2020*



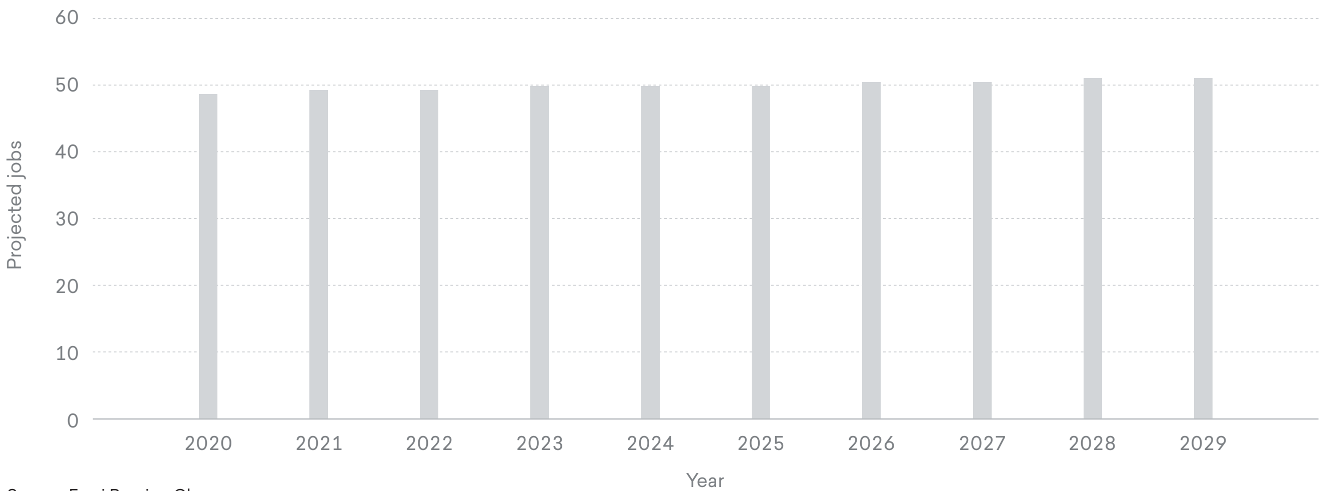
* Data reflect the most recent year for which data are available. Emsi Burning Glass data are updated quarterly.
Source: Emsi Burning Glass employment data.

4 Job numbers reflect Emsi Burning Glass's complete employment data, which includes the following four job classes: 1) employees who are counted in the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW), 2) employees who 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.

Industrial Systems and Mechatronics Engineering Technology program

The Industrial Systems and Mechatronics Engineering Technology program can lead students into a number of occupations, which may include electrical & electronic engineering technologists & technicians; electro-mechanical & mechatronics technologists & technicians; and finishers.[5] The five mapped occupations supported 49 jobs in the R-CCC Service Area economy in 2020. Over the next 10 years, these jobs are expected to grow 0.5% (Figure 1.2). In 2020, there were two job openings[6] within the mapped occupations. The average median annual wage for these openings was $55,017.

Figure 1.2: PROJECTED JOB GROWTH IN THE R-CCC SERVICE AREA OF INDUSTRIAL SYSTEMS AND MECHATRONICS ENGINEERING TECHNOLOGY PROGRAM MAPPED OCCUPATIONS



Source: Emsi Burning Glass.

The two job openings are being filled by the 22 Industrial Systems and Mechatronics Engineering Technology program R-CCC students. Subtracting this supply of human capital from the two annual openings, we arrive at 20 students, or a surplus of 20.[7] This means there is too much supply of trained workers in this area to meet the need of regional employers. In 2020, regional employers posted six unique job postings at the associate degree level or below for these

5 See Appendix 1 for a complete list of mapped occupations.
6 The job openings reported in this analysis are specific to students entering the workforce with an associate degree and below.
7 For the purposes of this analysis, only R-CCC students were considered when comparing to annual openings.

occupations in the R-CCC Service Area.[8] The top companies posting are Enviva, LP; Nucor Corporation; and Action Technologies, Inc. (Table 1.2).

Table 1.2: TOP COMPANIES POSTINGS JOBS FOR INDUSTRIAL SYSTEMS AND MECHATRONICS ENGINEERING TECHNOLOGY PROGRAM MAPPED OCCUPATIONS

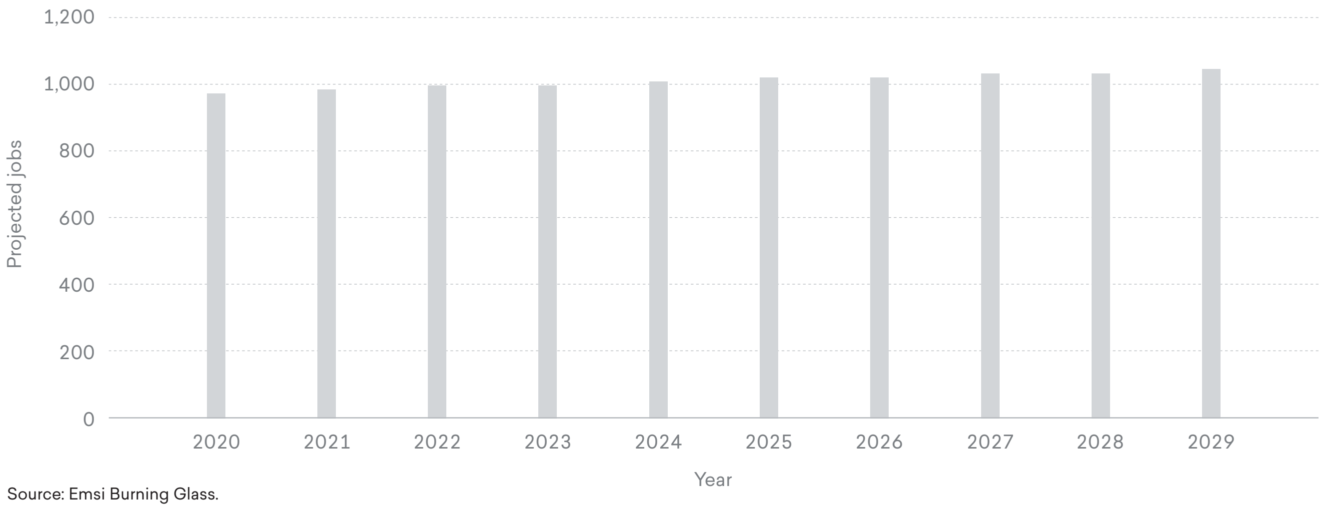
Company	Number of unique postings
Enviva, LP	3
Nucor Corporation	2
Action Technologies, Inc.	1
Army National Guard	1
North Carolina Department of Transportation	1

Source: Emsi Burning Glass Job Postings Analytics data.

Criminal Justice Technology program

The Criminal Justice Technology program can lead students into a number of occupations, which may include emergency management directors; police & sheriffs patrol officers; and compliance officers.[9] The 18 mapped occupations supported 966 jobs in the R-CCC Service Area economy in 2020. Over the next 10 years, these jobs are expected to grow 0.9% (Figure 1.3). In 2020, there were 34 job openings within the mapped occupations. The average median annual wage for these openings was $45,047.

Figure 1.3: PROJECTED JOB GROWTH IN THE R-CCC SERVICE AREA OF CRIMINAL JUSTICE TECHNOLOGY PROGRAM MAPPED OCCUPATIONS



Source: Emsi Burning Glass.

8 Job openings and job postings come from different data sources and can therefore differ from each other. They both provide insights into local employer demand. Job openings are from government data sources and, while lagged, can be more stable. Job postings reflect real-time employer demand but can have more fluctuations.

9 For a complete list of mapped occupations see Appendix 1.

The 34 job openings are in part being filled by the one Criminal Justice Technology program R-CCC completer. Subtracting this supply of human capital from the 34 annual openings, we arrive at 33 job openings, or a gap of 33. This means there is not enough supply of trained workers in this area to meet the need of regional employers. In 2020, regional employers posted 22 unique job postings at the associate degree level or below for these occupations in the R-CCC Service Area. A few of the top posting companies are NC Department of Public Safety; The Geo Group, Inc.; and Vidant Health (Table 1.3).

Table 1.3: TOP COMPANIES POSTINGS JOBS FOR CRIMINAL JUSTICE TECHNOLOGY PROGRAM MAPPED OCCUPATIONS

Company	Number of unique postings
NC Department of Public Safety	4
Roanoke-Chowan Community College	4
The Geo Group, Inc.	4
Vidant Health	4
The Wendy's Company	3
Hertford County Northern Rural Water District	2
Nucor Corporation	2
Smithfield Foods, Inc.	2
The Methodist Home for Children, Inc.	2
Allied Universal	1

Source: Emsi Burning Glass Job Postings Analytics data.

Early Childhood Education program

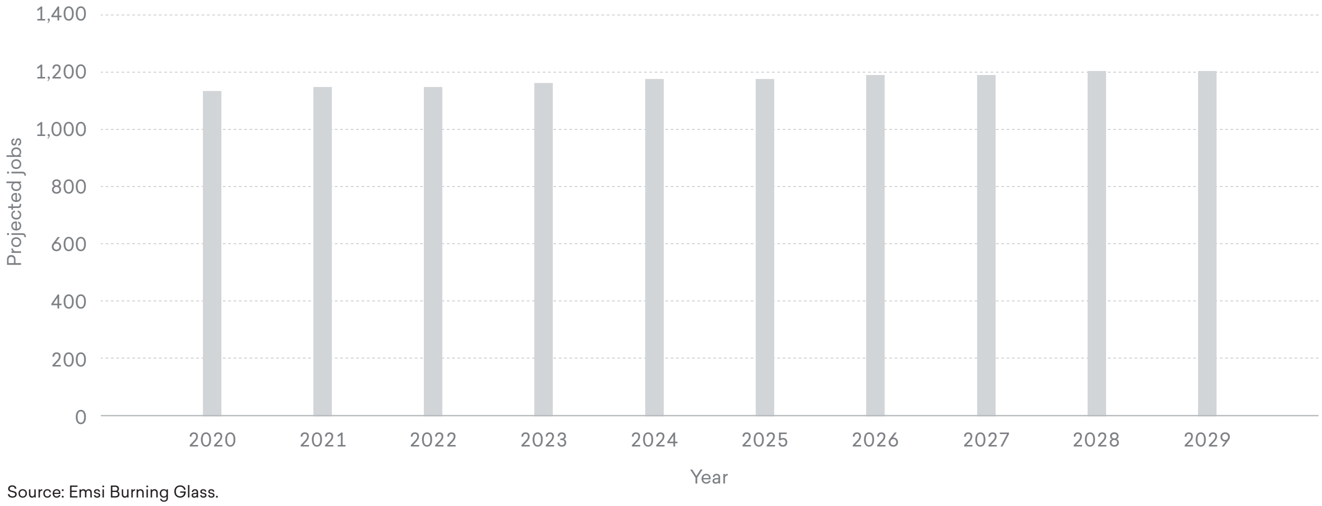
The Early Childhood Education program can lead students into a number of occupations, which may include preschool teachers, except special education; childcare workers; and counseling, & school psychologists.[10] The 12 mapped occupations supported 1,132 jobs in the R-CCC Service Area economy in 2020. Over the next 10 years, these jobs are expected to grow 0.8% (Figure 1.4). In 2020, there were 25 job openings within the mapped occupations. The average median annual wage for these openings was $39,844.

The 25 annual job openings are in part being filled by the one Early Childhood Education program R-CCC completer. Subtracting this supply of human capital from the 25 annual openings, we arrive at 24 job openings, or a gap of 24. This means there is not enough supply of trained workers in this area to meet the need of regional employers. In 2020, regional employers posted eight unique job postings at the associate degree level or below for these occupations in the

10 For a complete list of mapped occupations see Appendix 1.

R-CCC Service Area. The top companies posting are County of Northampton; Kipp Enc Public Schools; and Bertie County Schools (Table 1.4).

Figure 1.4: PROJECTED JOB GROWTH IN THE R-CCC SERVICE AREA OF EARLY CHILDHOOD EDUCATION PROGRAM MAPPED OCCUPATIONS



Source: Emsi Burning Glass.

Table 1.4: TOP COMPANIES POSTINGS JOBS FOR EARLY CHILDHOOD EDUCATION PROGRAM MAPPED OCCUPATIONS

Company	Number of unique postings
County of Northampton	10
Kipp Enc Public Schools	7
Bertie County Schools	5
Hertford County School District	5
Kipp Foundation	5
VIPKID	4
Little Stepping Stones	3
Vidant Health	3
Eduro Healthcare, LLC	2
The Methodist Home for Children, Inc.	2

Source: Emsi Burning Glass Job Postings Analytics data.

CHAPTER 2:

Economic value of individual programs

INDUSTRIAL SYSTEMS AND MECHATRONICS ENGINEERING TECHNOLOGY PROGRAM

The Industrial Systems and Mechatronics Engineering Technology program[11] was recently established in 2002. In FY 2019-20, R-CCC enrolled 22 students in the program.

CAREER OUTLOOK

The Industrial Systems and Mechatronics Engineering Technology program can lead students into a number of occupations, which may include electrical & electronic engineering technologists & technicians; electro-mechanical & mechatronics technologists & technicians; and finishers.

Using the regional number of annual openings for these occupations (two) and subtracting the FY 2019-20 R-CCC students that may fill these openings (22), we arrive at a surplus of 20 students.[12] There are six unique job postings at the associate degree or below for these occupations in the R-CCC Service Area. The top three posting companies are Enviva, LP; Nucor Corporation; and Action Technologies, Inc.

PROGRAM TO OCCUPATION MAPPING METRICS IN THE R-CCC SERVICE AREA

Number of occupations	5
Jobs (2020)	49
Projected avg. job growth (2020-2029)	+0.5%
Annual openings (2020)	2
Median annual wage (2020)*	$55,017

* The median annual wage reflects all award levels.

ALUMNI IMPACT

Former students of R-CCC's Industrial Systems and Mechatronics Engineering Technology program added $95.0 thousand in income to the R-CCC Service Area economy in FY 2019-20. This figure represents the increased wages collected by former students active today in the regional workforce as a direct result of their education, the increased output of businesses that employ these students, and the multiplier effects that occur.

ALUMNI LIFETIME EARNINGS INCREASE AND IMPACT

Lifetime earnings increase per completer
$618.3 thousand

Total alumni impact in FY 2019-20
$95.0 thousand

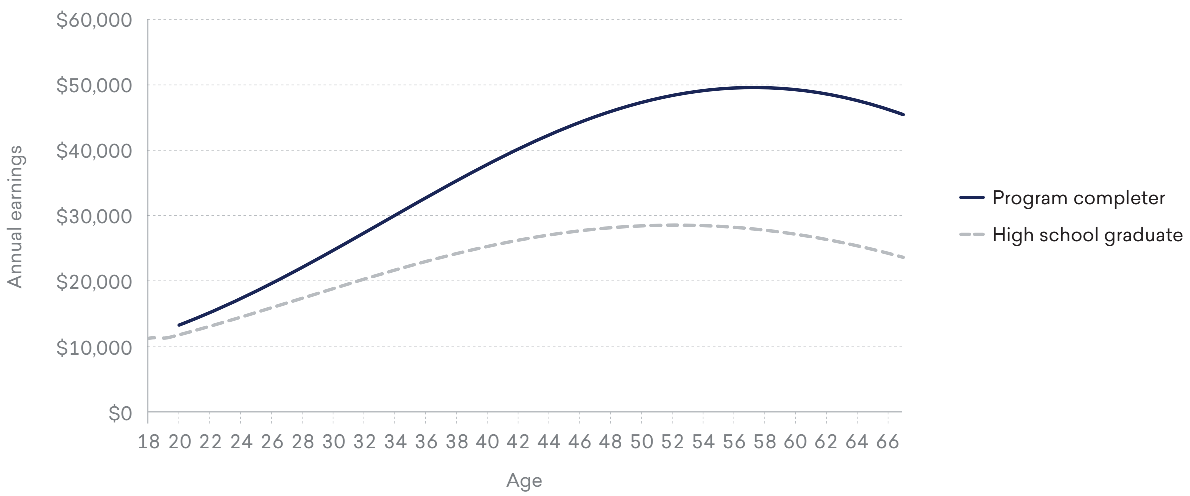
11 The Industrial Systems and Mechatronics Engineering Technology program is defined by the following Classification of Instructional Programs (CIP) codes: Electromechanical & Instrumentation & Maintenance Technologies/Technicians, Other (15.0499) and Electromechanical Technology/Electromechanical Engineering Technology (15.0403).

12 For the purposes of this analysis, only R-CCC students were considered when comparing to annual openings.

STUDENT RETURN ON INVESTMENT

To earn a degree in the program, students experience costs in the form of tuition and fees, books and supplies, and the opportunity cost of attending school instead of working. In return for this investment, students can earn higher wages. For every dollar students invest in their education in the program, they will receive $19.70 back over the course of their working lives. This investment can also be seen in terms of a rate of return of 29.2%. This is an impressive return, especially when compared to the U.S. stock market 30-year average return of 10.6%.

LIFETIME EARNINGS OF A PROGRAM COMPLETER
COMPARED TO A HIGH SCHOOL GRADUATE



Source: Emsi Burning Glass impact model.

TAXPAYER BENEFITS

Taxpayers will receive an estimated present value of $106.1 thousand in added tax revenue stemming from the students' higher lifetime earnings and the increased output of businesses. Savings to the public sector add another estimated $6.1 thousand in benefits due to a reduced demand for government-funded social services in North Carolina. Throughout the students' working lives, North Carolina taxpayers will receive a total of $112.2 thousand in benefits.

Throughout the students' working lives, **North Carolina taxpayers** gain in added tax revenue and public sector savings

$112.2 thousand

CRIMINAL JUSTICE TECHNOLOGY PROGRAM

The Criminal Justice Technology program[13] was established in 1997. In FY 2019-20, R-CCC enrolled 13 students in the program. Of these students, one graduated with an associate degree in FY 2019-20.

CAREER OUTLOOK

The Criminal Justice Technology program can lead students into a number of occupations, which may include emergency management directors; police & sheriffs patrol officers; and compliance officers.

Using the regional number of annual openings for these occupations (34) and subtracting the FY 2019-20 R-CCC completer that may fill these openings (one), we arrive at a gap of 33 job openings.[14] There are 22 unique job postings at the associate degree or below for these occupations in the R-CCC Service Area. A few of the top posting companies are NC Department of Public Safety; The Geo Group, Inc.; and Vidant Health.

PROGRAM TO OCCUPATION MAPPING METRICS IN THE R-CCC SERVICE AREA

Number of occupations	18
Jobs (2020)	966
Projected avg. job growth (2020-2029)	+0.9%
Annual openings (2020)	34
Median annual wage (2020)*	$45,047

* The median annual wage reflects all award levels.

ALUMNI IMPACT

Former students of R-CCC's Criminal Justice Technology program added $213.1 thousand in income to the R-CCC Service Area economy in FY 2019-20. This figure represents the increased wages collected by former students active today in the regional workforce as a direct result of their education, the increased output of businesses that employ these students, and the multiplier effects that occur.

ALUMNI LIFETIME EARNINGS INCREASE AND IMPACT

Lifetime earnings increase per completer
$318.3 thousand

Total alumni impact in FY 2019-20
$213.1 thousand

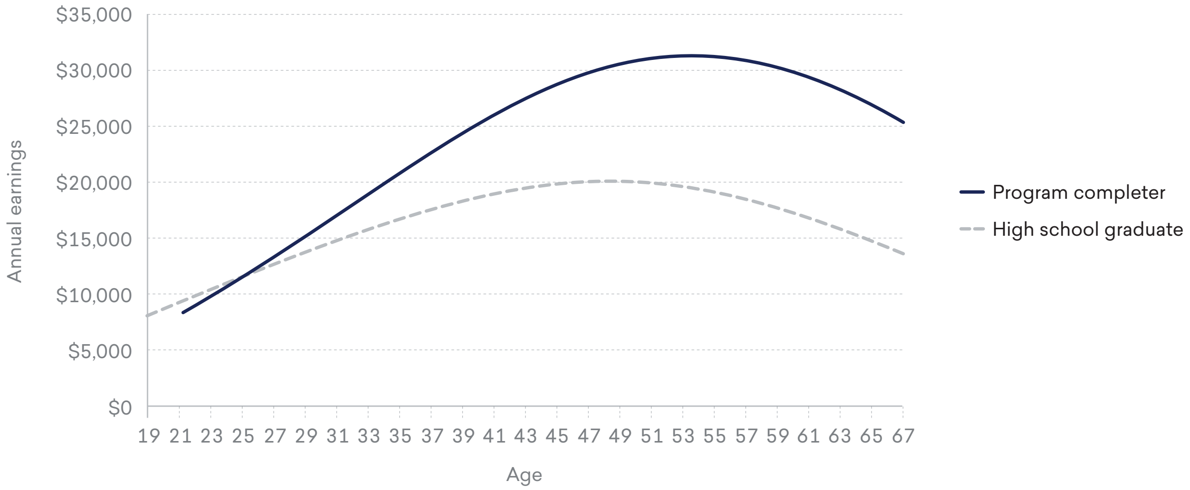
13 The Criminal Justice Technology program is defined by the following CIP code: Criminal Justice/Safety Studies (43.0104).

14 For the purposes of this analysis, only R-CCC completers were considered when comparing to annual openings.

STUDENT RETURN ON INVESTMENT

To earn a degree in the program, students experience costs in the form of tuition and fees, books and supplies, and the opportunity cost of attending school instead of working. In return for this investment, students can earn higher wages. For every dollar students invest in their education in the program, they will receive $7.70 back over the course of their working lives. This investment can also be seen in terms of a rate of return of 18.9%. This is an impressive return, especially when compared to the U.S. stock market 30-year average return of 10.6%.

LIFETIME EARNINGS OF A PROGRAM COMPLETER
COMPARED TO A HIGH SCHOOL GRADUATE



Source: Emsi Burning Glass impact model.

TAXPAYER BENEFITS

Taxpayers will receive an estimated present value of $21 thousand in added tax revenue stemming from the students' higher lifetime earnings and the increased output of businesses. Savings to the public sector add another estimated $3.1 thousand in benefits due to a reduced demand for government-funded social services in North Carolina. Throughout the students' working lives, North Carolina taxpayers will receive a total of $24.0 thousand in benefits.

Throughout the students' working lives, **North Carolina taxpayers** gain in added tax revenue and public sector savings

$24.0 thousand

EARLY CHILDHOOD EDUCATION PROGRAM

The Early Childhood Education program[15] was established in 1997. In FY 2019-20, R-CCC enrolled 11 students in the program. Of these students, one graduated with an associate degree in FY 2019-20.

CAREER OUTLOOK

The Early Childhood Education program can lead students into a number of occupations, which may include preschool teachers, except special education; childcare workers; and counseling, & school psychologists.

Using the regional number of annual openings for these occupations (25) and subtracting the FY 2019-20 R-CCC completer that may fill these openings (one), we arrive at a gap of 24 job openings.[16] There are eight unique job postings at the associate degree or below for these occupations in the R-CCC Service Area. The top three posting companies are County of Northampton; Kipp Enc Public Schools; and Bertie County Schools.

PROGRAM TO OCCUPATION MAPPING METRICS IN THE R-CCC SERVICE AREA

Number of occupations	12
Jobs (2020)	1,132
Projected avg. job growth (2020-2029)	+0.8%
Annual openings (2020)	25
Median annual wage (2020)*	$39,844

* The median annual wage reflects all award levels.

ALUMNI IMPACT

Former students of R-CCC's Early Childhood Education program added $166.7 thousand in income to the R-CCC Service Area economy in FY 2019-20. This figure represents the increased wages collected by former students active today in the regional workforce as a direct result of their education, the increased output of businesses that employ these students, and the multiplier effects that occur.

ALUMNI LIFETIME EARNINGS INCREASE AND IMPACT

Lifetime earnings increase per completer
$167.7 thousand

Total alumni impact in FY 2019-20
$166.7 thousand

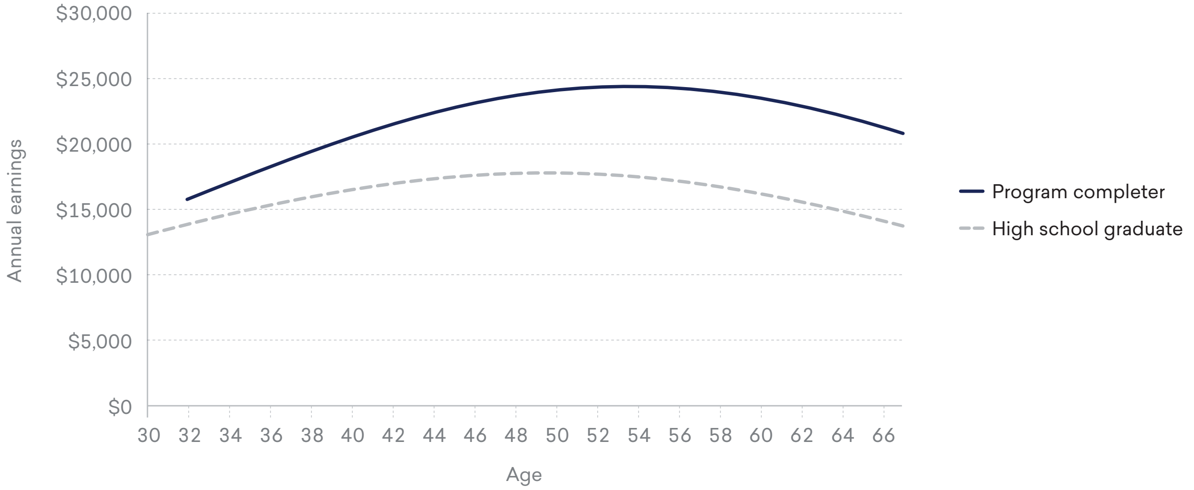
15 The Early Childhood Education program is defined by the following CIP code: Early Childhood Education & Teaching (13.1210).

16 For the purposes of this analysis, only R-CCC completers were considered when comparing to annual openings.

STUDENT RETURN ON INVESTMENT

To earn a degree in the program, students experience costs in the form of tuition and fees, books and supplies, and the opportunity cost of attending school instead of working. In return for this investment, students can earn higher wages. For every dollar students invest in their education in the program, they will receive $1.30 back over the course of their working lives. This investment can also be seen in terms of a rate of return of 6.3%.

LIFETIME EARNINGS OF A PROGRAM COMPLETER COMPARED TO A HIGH SCHOOL GRADUATE



Source: Emsi Burning Glass impact model.

TAXPAYER BENEFITS

Taxpayers will receive an estimated present value of $5.1 thousand in added tax revenue stemming from the students' higher lifetime earnings and the increased output of businesses. Savings to the public sector add another estimated $1.8 thousand in benefits due to a reduced demand for government-funded social services in North Carolina. Throughout the students' working lives, North Carolina taxpayers will receive a total of $7.0 thousand in benefits.

Throughout the students' working lives, **North Carolina taxpayers** gain in added tax revenue and public sector savings

$7.0 thousand

CHAPTER 3:

Methodology

For the purpose of explaining the methodology, one program, Industrial Systems and Mechatronics Engineering Technology, will be used as an example. The results for each program under study follows the same methodology outlined below.

ECONOMIC IMPACT ANALYSIS

R-CCC provides its Industrial Systems and Mechatronics Engineering Technology program's students with the knowledge, skills, and abilities they need to become productive citizens and add to the overall output of the region. In this section, we describe the methodology in calculating the alumni impact, which measures the income added in the region as former students of the program expand the regional economy's stock of human capital.

ECONOMIC IMPACT

Economic impact measures

Alumni impact analysis

Economic impact measures

When estimating the alumni impact, we measure a net impact, not a gross impact. Gross impact represents an upper-bound estimate in terms of capturing all activity stemming from the alumni; however, a net impact reflects a truer measure since it demonstrates what would not have been generated in the regional economy if not for these selected programs at R-CCC.

Economic impact analyses use different types of impacts to estimate the results. The impact focused on in this study assesses the change in income. This measure is similar to the commonly used gross regional product (GRP). Income may be further broken out into the **labor income impact**, also known as earnings, which assesses the change in employee compensation; and the **non-labor income impact**, which assesses the change in business profits. Together, labor income and non-labor income sum to total income.

Another way to state the impact is in terms of **jobs**, 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 regional economy through intermediary transactions and costs.[17] All of these measures—added labor and non-labor income, total income, jobs, and sales—are used to estimate the economic impact results presented in this chapter. The analysis breaks out the impact measures into different

17 See Appendix 4 for an example of the intermediary costs included in the sales impact but not in the income impact.

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, for example, the increased wages of the Industrial Systems and Mechatronics Engineering Technology program's alumni.
- 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 **induced effect** refers to the economic activity created by the household sector as the businesses affected by the initial, direct, and indirect effects raise salaries or hire more people.

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 chapter 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 Burning Glass	Initial	Direct	Indirect	Induced
IMPLAN	Direct	Indirect		Induced

Multiplier effects in this analysis are derived using Emsi Burning Glass Multi-Regional Social Accounting Matrix (MR-SAM) input-output model that captures the interconnection of industries, government, and households in the region. The Emsi Burning Glass MR-SAM contains approximately 1,000 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. The multi-regional capacity of the MR-SAM allows impacts to be measured in the region and state simultaneously, taking into account the program's activity in each area, as well as each area's economic characteristics. In this analysis, impacts on the region include impacts from the program's regional activity, as well as the indirect and induced multiplier effects that reach the region from the program's activity in the rest of the state. For more information on the Emsi Burning Glass MR-SAM model and its data sources, see Appendix 5.

More specifically, this report analyzes the economic impact attributable to the alumni of the college's Industrial Systems and Mechatronics Engineering Technology program. In order to capture the impact at the program level, we must map the program to the occupations students are likely to enter upon completion of the program. This is done by mapping the Classification of Instructional Programs (CIP) codes for the program to the appropriate Standard Occupational Classification (SOC) codes and then to the appropriate industries. CIP codes are how the National Center for Education Statistics (NCES) categorizes and tracks an enrollee's field of study. SOC codes are used by the Bureau of Labor Statistics (BLS) to categorize and track employment trends for jobs with similar duties, skills, and/or education. The link between CIPs and SOCs was provided by Emsi Burning Glass and reviewed by R-CCC (Appendix 1). This mapping provides the basis for calculating and attributing earnings to a program. However, not all students in the program will enter these mapped occupations. Some students will enter occupations outside their field of study. Using student data from other colleges and Emsi Burning Glass profiles data, Emsi Burning Glass calculated the percentage of students working in-field and out-of-field by SOC code. The mapped occupation specific earnings are then weighted by the average regional earnings from the proportion of program students that work out-of-field. For example, if 60% of program students are estimated to work in-field, then the average earnings will be weighted by 60% mapped occupation earnings and 40% average regional earnings.

From the CIP to SOC mapping, we use an inverse staffing pattern to determine the industries currently employing the occupations. This is done in the Emsi Burning Glass MR-SAM by combining data from the national Occupational Employment Statistics (OES) staffing pattern, projections from the National Industry-Occupation Employment Matrix, and Emsi Burning Glass's proprietary employment data.

Alumni impact analysis

In this section, we estimate the economic impact stemming from the added labor income of Industrial Systems and Mechatronics Engineering Technology program alumni in combination with their employers' added non-labor income. This impact is based on the number of students who have attended R-CCC's Industrial Systems and Mechatronics Engineering Technology program *throughout its history*. We then use this total number to consider the impact of those students in the single FY 2019-20. Former students who earned a degree as well as those who may not have finished their degree or did not take courses for credit are considered alumni.

While attending R-CCC's Industrial Systems and Mechatronics Engineering Technology program, students gain 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 R-CCC's Industrial Systems and Mechatronics Engineering Technology program's alumni 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 of these is the added labor income of R-CCC's former students. The second component of the initial effect is comprised of the added non-labor income of the businesses that employ the former students of the Industrial Systems and Mechatronics Engineering Technology program.

We begin by estimating the portion of the program's alumni who are employed in the workforce. To estimate the historical employment patterns of alumni in the region, 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;[18] 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) state migration data from the Internal Revenue Service. The result is the estimated portion of alumni from each previous year who were still actively employed in the region as of FY 2019-20.

The next step is to quantify the skills and human capital that alumni of the Industrial Systems and Mechatronics Engineering Technology program acquired from the college. We use the students' production of CHEs as a proxy for accumulated human capital. The average number of CHEs completed per student in FY 2019-20 was 5.9. To estimate the number of CHEs present in the workforce during the analysis year, we use the college's historical Industrial Systems and Mechatronics Engineering Technology program's student headcount over the past 18 years, from FY 2002-03 to FY 2019-20.[19] We multiply the 5.9 average CHEs per student by the headcounts that we estimate are still actively employed from each of the previous years.[20] Students who enroll in the program at the college more than one year are 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 637.2 CHEs from program alumni active in the workforce.

18 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.

19 The 18-year time horizon is equal to the number of years that R-CCC's Industrial Systems and Mechatronics Engineering Technology program was in operation since it was established in 2002.

20 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.

Next, we estimate the value of the CHEs, or the skills and human capital acquired by alumni of the Industrial Systems and Mechatronics Engineering Technology program. This is done using the *incremental* added labor income stemming from the students' higher wages. The incremental added labor income is the difference between the wage earned by the Industrial Systems and Mechatronics Engineering Technology program's alumni and the alternative wage they would have earned had they not attended the program. To calculate the wage earned by the Industrial Systems and Mechatronics Engineering Technology program's alumni, we use a CIP to SOC mapping and the earnings associated with the occupations students of the Industrial Systems and Mechatronics Engineering Technology program are likely to enter. For multiple occupations, we use a weighted average by annual job openings to calculate the likely average earnings of workers in occupations mapped to the Industrial Systems and Mechatronics Engineering Technology program. This is then adjusted to reflect each education level. Note that for workers with only a high school diploma or who have not achieved a high school diploma, the earnings are weighted by the average earnings for people with that level of education in the region; in other words, the adjustment is dampened.

Using the regional incremental earnings and distribution of credits completed, we estimate the program's average value per CHE to equal $106. This value represents the regional average incremental increase in wages that alumni of the Industrial Systems and Mechatronics Engineering Technology program 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 FY 2019-20, 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 6. 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 $67.8 thousand in gross labor income from increased wages received by former students in FY 2019-20 (as shown in Table 3.1).

Table 3.1: NUMBER OF R-CCC INDUSTRIAL SYSTEMS AND MECHATRONICS ENGINEERING TECHNOLOGY PROGRAM CHES IN THE WORKFORCE AND INITIAL LABOR INCOME CREATED IN THE R-CCC SERVICE AREA, FY 2019-20

Number of CHEs in workforce	637
Average value per CHE	$106
Initial labor income, gross	**$67,787**
Adjustments for counterfactual scenarios	
Percent reduction for alternative education opportunities	15%
Percent reduction for adjustment for labor import effects	50%
Initial labor income, net	**$28,809**

Source: Emsi Burning Glass impact model.

The next two rows in Table 3.1 show two adjustments used to account for counterfactual outcomes. 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 R-CCC's Industrial Systems and Mechatronics Engineering Technology program and subsequent influx of skilled labor into the regional economy. The first counterfactual scenario that we address is the adjustment for alternative education opportunities. In the counterfactual scenario where the program does not exist, we assume a portion of the program's alumni would have received a comparable education elsewhere in the region or would have left the region and received a comparable education and then returned to the region. The incremental added labor income that accrues to those students cannot be counted towards the added labor income from the Industrial Systems and Mechatronics Engineering Technology program's alumni. The adjustment for alternative education opportunities amounts to a 15% reduction of the $67.8 thousand in added labor income. This means that 15% of the added labor income from R-CCC's Industrial Systems and Mechatronics Engineering Technology program alumni would have been generated in the region anyway, even if the program did not exist. For more information on the alternative education adjustment, see Appendix 7.

The other adjustment in Table 3.1 accounts for the importation of labor. Suppose the Industrial Systems and Mechatronics Engineering Technology program did not exist and in consequence there were fewer skilled workers in the region. Businesses could still satisfy some of their need for skilled labor by recruiting from outside the R-CCC Service Area. We refer to this as the labor import effect. Lacking information on its possible magnitude, we assume 50% of the jobs that students fill at regional businesses could have been filled by workers recruited from outside the region if the Industrial Systems and Mechatronics Engineering Technology program did not exist.[21] Consequently, the gross labor income must be adjusted to account for the importation of this labor, since it would have happened regardless of the presence of the program. We conduct a sensitivity analysis for this assumption in Appendix 2. With the 50% adjustment, the net added labor income added to the economy comes to $28.8 thousand, as shown in Table 3.1.

The $28.8 thousand in added labor income appears under the initial effect in the labor income column of Table 3.2. To this we add an estimate for initial non-labor income. As discussed earlier in this section, businesses that employ former students of R-CCC's Industrial Systems and Mechatronics Engineering Technology program 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 ($28.8 thousand) to the six-digit NAICS industry sectors where students exiting the program are most likely to be employed. This allocation entails a process that maps the Industrial Systems and Mechatronics

21 A similar assumption is used by Walden (2014) in his analysis of the Cooperating Raleigh Colleges.

Engineering Technology program 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 MR-SAM model. Finally, we apply a matrix of wages by industry and by occupation from the MR-SAM model to map the occupational distribution of the $28.8 thousand in initial labor income effects to the detailed industry sectors in the MR-SAM model.[22]

Once these allocations are complete, we apply the ratio of non-labor to labor income provided by the MR-SAM model for each sector to our estimate of initial labor income. This computation yields an estimated $48.7 thousand in added non-labor income attributable to alumni of the college's Industrial Systems and Mechatronics Engineering Technology program. Summing initial labor and non-labor income together provides the total initial effect of alumni productivity in the R-CCC Service Area economy, equal to approximately $77.6 thousand. 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 MR-SAM model. We then run the values through the MR-SAM's multiplier matrix.

Table 3.2: R-CCC INDUSTRIAL SYSTEMS AND MECHATRONICS ENGINEERING TECHNOLOGY PROGRAM ALUMNI IMPACT, FY 2019-20

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$29**	**$49**	**$78**	**$244**	**<1**
Multiplier effect					
Direct effect	$3	$4	$7	$21	<1
Indirect effect	$0	$0	$1	$3	<1
Induced effect	$3	$6	$10	$27	<1
Total multiplier effect	**$6**	**$11**	**$17**	**$51**	**<1**
Total impact (initial + multiplier)	**$35**	**$60**	**$95**	**$295**	**1**

Source: Emsi Burning Glass impact model.

Table 3.2 shows the multiplier effects of the Industrial Systems and Mechatronics Engineering Technology program's 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 the program's alumni. The final results are $6.5 thousand in added labor income and $11 thousand in added non-labor income, for an overall total of $17.4 thousand in multiplier effects. The grand total of the alumni impact is $95 thousand in total added income, the sum of all initial and multiplier labor and non-labor income effects. This is equivalent to supporting one job.

22 For example, if the MR-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.

STUDENT 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.

To enroll in postsecondary education, the Industrial Systems and Mechatronics Engineering Technology program's students pay money for tuition and forego monies that otherwise they would have earned had they chosen to work instead of learn. From the perspective of students, education is the same as an investment; i.e., they incur a cost, or put up a certain amount of money, with the expectation of receiving benefits in return. The total costs consist of the tuition and fees that students pay and the opportunity cost of foregone time and money. The benefits are the higher earnings that students receive as a result of their education.

STUDENT COSTS

Out-of-pocket expenses

Opportunity costs

STUDENT BENEFITS

Higher earnings from education

Calculating student costs

Industrial Systems and Mechatronics Engineering Technology program student costs consist of two main items: direct outlays and opportunity costs. Direct outlays include tuition and fees, equal to $2.7 thousand. Direct outlays also include the cost of books and supplies. On average, full-time students spent $2,100 each on books and supplies during the reporting year.[23] Multiplying this figure by the number of full-time equivalents (FTEs) produced by the program in FY 2019-20[24] generates a total cost of $8.4 thousand for books and supplies.

In addition to the cost of tuition, books, and supplies, Industrial Systems and Mechatronics Engineering Technology program students also experienced an opportunity cost of attending college during the analysis year. Opportunity cost is the most difficult component of student costs to estimate. It measures the value of time and earnings foregone by students who attend the program's

23 Based on data provided by R-CCC.

24 A single FTE is equal to 30 CHEs, so there were 4 FTEs produced by students in FY 2019-20, equal to 130 CHEs divided by 30.

classes rather than work. To calculate it, we need to know the difference between the students' full earning potential and what they actually earn while enrolled in the program.

We derive the students' full earning potential by weighting the average annual earnings levels according to the education level breakdown of the student population at the start of the analysis year.[25] However, the earnings levels reflect what average workers earn at the midpoint of their careers, not while attending the college. Because of this, we adjust the earnings levels to the average age of the program's student population (18) to better reflect their wages at their current age.[26] This calculation yields an average full earning potential of $12,666 per student.

In determining how much students earn while enrolled in postsecondary education, an important factor to consider is the time that they actually spend on postsecondary education, since this is the only time that they are required to give up a portion of their earnings. We use the CHE production of the Industrial Systems and Mechatronics Engineering Technology program's students 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 foregone earnings. Overall, students attending R-CCC in FY 2019-20 earned an average of 15.0 CHEs per student (excluding dual credit high school students), which is approximately equal to 50% of a full academic year.[27] We thus include no more than $6,333 (or 50%) of the students' full earning potential in the opportunity cost calculations.

Another factor to consider is the employment status of the Industrial Systems and Mechatronics Engineering Technology program's students while enrolled in postsecondary education. It is estimated that 75% of students are employed.[28] For the remainder of students, we assume that they are either seeking work or planning to seek work once they complete their educational goals. By choosing to enroll, therefore, non-working students give up everything that they can potentially earn during the academic year (i.e., the $6,333). The total value of their foregone earnings thus comes to $1.6 thousand.

Working students are able to maintain all or part of their earnings 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 70% of what they would have earned had they chosen to work full-time rather than go to college.[29] The remaining 30% comprises the percentage of their full

25 This is based on students who reported their prior level of education to R-CCC. The prior level of education data was then adjusted to exclude dual credit high school students.

26 Further discussion on this adjustment appears in Appendix 6.

27 Equal to 15.0 CHEs divided by 30, the assumed number of CHEs in a full-time academic year.

28 Emsi Burning Glass provided an estimate of the percentage of students employed because R-CCC was unable to provide data. This figure excludes dual credit high school students, who are not included in the opportunity cost calculations.

29 The 70% assumption is based on the average hourly wage of jobs 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).

earning potential that they forego. Obviously, this assumption varies by person; some students forego more and others less. Since we do not know the actual jobs that students hold while attending, the 30% in foregone earnings serves as a reasonable average.

Working students of the program also give up a portion of their leisure time in order to attend higher education institutions. According to the Bureau of Labor Statistics American Time Use Survey, students forego up to 0.5 hours of leisure time per day.[30] 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 is $1.7 thousand, equal to the sum of their foregone earnings ($1.4 thousand) and foregone leisure time ($0.3 thousand).

The steps leading up to the calculation of the Industrial Systems and Mechatronics Engineering Technology program's student costs appear in Table 3.3. Direct outlays amount to $11.2 thousand, the sum of tuition and fees ($2.7 thousand) and books and supplies ($8.4 thousand). Opportunity costs for working and non-working students amount to $3.3 thousand.[31] Summing direct outlays and opportunity costs together yields a total of $14.5 thousand in present value student costs.

Table 3.3: PRESENT VALUE OF STUDENT COSTS, FY 2019-20 (THOUSANDS)

Direct outlays in FY 2019-20	
Tuition and fees	$3
Books and supplies	$8
Total direct outlays	**$11**
Opportunity costs in FY 2019-20	
Earnings foregone by non-working students	$2
Earnings foregone by working students	$1
Value of leisure time foregone by working students	$<1
Total opportunity costs	**$3**
Total present value student costs	**$15**

Source: Based on data provided by R-CCC and outputs of the Emsi Burning Glass impact model.

Linking education to earnings

Having estimated the costs of education to students of the Industrial Systems and Mechatronics Engineering Technology program, we weigh these costs against the benefits that students receive in return. The relationship between education

30 "Charts by Topic: Leisure and Sports Activities," American Time Use Survey, Last modified December 2016. http://www.bls.gov/tus/charts/leisure.htm.

31 Residual aid is the remaining portion of scholarship or grant aid distributed directly to a student after the college applies tuition and fees.

and earnings is well documented and forms the basis for determining student benefits. State mean earnings levels at the midpoint of the average-aged worker's career increase as people achieve higher levels of education. The differences between state earnings levels define the incremental benefits of moving from one education level to the next.

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 calculate the future benefits stream to the college's FY 2019-20 Industrial Systems and Mechatronics Engineering Technology program's students first by determining their average annual increase in earnings, equal to $22.8 thousand. This value represents the higher wages that accrue to students at the midpoint of their careers and is calculated based on the marginal wage increases of the CHEs that students complete while enrolled in the program. Using the state of North Carolina earnings, the marginal wage increase per CHE is $175. For a full description of the methodology used to derive the $22.8 thousand, see Appendix 6.

The second step is to project the $22.8 thousand annual increase in earnings into the future, for as long as students remain in the workforce. We do this using the Mincer function to predict the change in earnings at each point in an individual's working career.[32] The Mincer function originated from Mincer's seminal work on human capital (1958). The function estimates earnings using an individual's years of education and post-schooling experience. While some have criticized Mincer's earnings function, it is still upheld in recent data and has served as the foundation for a variety of research pertaining to labor economics. Card (1999 and 2001) addresses a number of these criticisms using U.S. based research over the last three decades and concludes that any upward bias in the Mincer parameters is on the order of 10% or less. We use state-specific and education level-specific Mincer coefficients. To account for any upward bias, we incorporate a 10% reduction in our projected earnings, otherwise known as the ability bias. With the $22.8 thousand 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, 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 3.4.

As shown in Table 3.4, the $22.8 thousand in gross higher earnings occurs around Year 23, 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 the Mincer function, the gross higher earnings that accrue to students in the years leading up to the midpoint are less than $22.8 thousand and the gross higher earnings in the years after the midpoint are greater than $22.8 thousand. On a per student basis, the total increase in lifetime earnings of students that complete the program is $618.3 thousand (Figure 3.1).

32 Appendix 6 provides more information on the Mincer function and how it is used to predict future earnings growth.

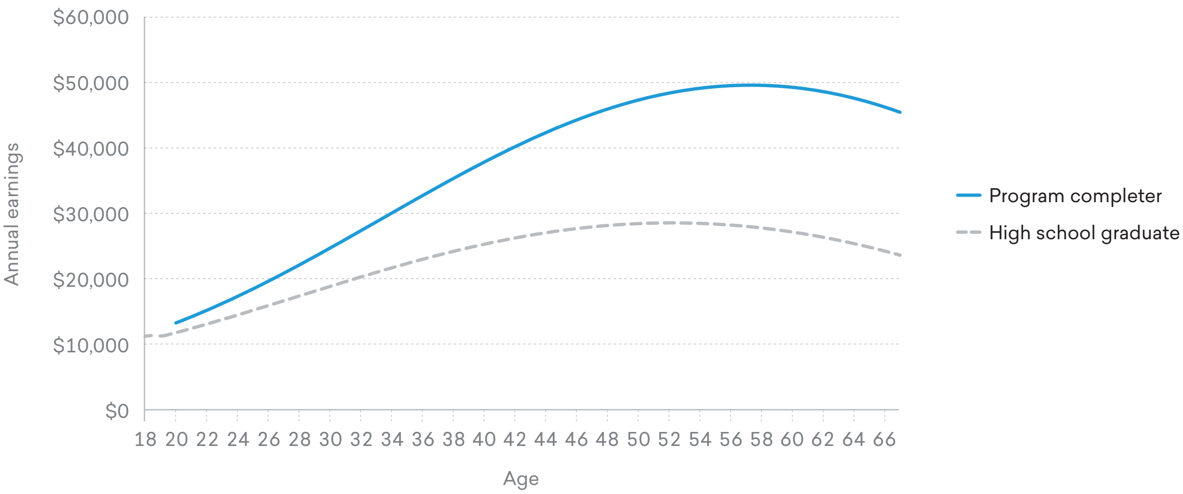
Table 3.4: PROJECTED BENEFITS AND COSTS, INDUSTRIAL SYSTEMS AND MECHATRONICS ENGINEERING TECHNOLOGY PROGRAM STUDENT PERSPECTIVE

1	2	3	4	5	6
Year	**Gross higher earnings to students (thousands)**	**% active in workforce***	**Net higher earnings to students (thousands)**	**Student costs (thousands)**	**Net cash flow (thousands)**
0	$6.6	<1%	<$0.1	$14.5	-$14.5
1	$7.2	<1%	<$0.1	$0.0	<$0.1
2	$7.7	<1%	<$0.1	$0.0	<$0.1
3	$8.3	1%	$0.1	$0.0	$0.1
4	$8.9	3%	$0.3	$0.0	$0.3
5	$9.5	97%	$9.3	$0.0	$9.3
6	$10.2	98%	$9.9	$0.0	$9.9
7	$10.9	98%	$10.6	$0.0	$10.6
8	$11.5	98%	$11.3	$0.0	$11.3
9	$12.3	98%	$12.0	$0.0	$12.0
10	$13.0	98%	$12.7	$0.0	$12.7
11	$13.7	97%	$13.4	$0.0	$13.4
12	$14.5	97%	$14.1	$0.0	$14.1
13	$15.2	97%	$14.8	$0.0	$14.8
14	$16.0	97%	$15.5	$0.0	$15.5
15	$16.8	97%	$16.3	$0.0	$16.3
16	$17.6	97%	$17.0	$0.0	$17.0
17	$18.3	97%	$17.7	$0.0	$17.7
18	$19.1	97%	$18.4	$0.0	$18.4
19	$19.9	96%	$19.1	$0.0	$19.1
20	$20.6	96%	$19.8	$0.0	$19.8
21	$21.3	96%	$20.5	$0.0	$20.5
22	$22.1	96%	$21.1	$0.0	$21.1
23	$22.8	96%	$21.8	$0.0	$21.8
24	$23.4	96%	$22.4	$0.0	$22.4
25	$24.1	95%	$22.9	$0.0	$22.9
26	$24.7	95%	$23.5	$0.0	$23.5
27	$25.3	95%	$24.0	$0.0	$24.0
28	$25.8	95%	$24.4	$0.0	$24.4
29	$26.3	94%	$24.8	$0.0	$24.8
30	$26.8	94%	$25.2	$0.0	$25.2
31	$27.2	94%	$25.5	$0.0	$25.5
32	$27.6	93%	$25.7	$0.0	$25.7
33	$27.9	93%	$25.9	$0.0	$25.9
34	$28.2	92%	$26.0	$0.0	$26.0
35	$28.4	92%	$26.1	$0.0	$26.1
36	$28.5	91%	$26.1	$0.0	$26.1
37	$28.7	91%	$26.1	$0.0	$26.1
38	$28.7	90%	$25.9	$0.0	$25.9
39	$28.7	90%	$25.7	$0.0	$25.7
40	$28.7	89%	$25.5	$0.0	$25.5
41	$28.6	88%	$25.2	$0.0	$25.2
42	$28.4	87%	$24.8	$0.0	$24.8
43	$28.2	87%	$24.4	$0.0	$24.4
44	$27.9	86%	$23.9	$0.0	$23.9
45	$27.6	85%	$23.4	$0.0	$23.4
46	$27.3	84%	$22.8	$0.0	$22.8
47	$26.9	83%	$22.2	$0.0	$22.2
Present value			**$285.3**	**$14.5**	**$270.8**

* Includes the "settling-in" factors and attrition.
Source: Emsi Burning Glass impact model.

Benefit-cost ratio	Internal rate of return	Payback period (years)
19.7	29.2%	5.5

Figure 3.1: LIFETIME EARNINGS OF AN INDUSTRIAL SYSTEMS AND MECHATRONICS ENGINEERING TECHNOLOGY PROGRAM COMPLETER COMPARED TO A HIGH SCHOOL GRADUATE



Source: Emsi Burning Glass impact model.

The final step in calculating the future benefits stream of the Industrial Systems and Mechatronics Engineering Technology program's students 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 3.4 and represents the percentage of the FY 2019-20 Industrial Systems and Mechatronics Engineering Technology program 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 at the college 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 earlier, 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 degree-seeking students who do not complete during the analysis year.

Beyond the first five years of the time horizon, students will leave the workforce for any number of reasons, whether 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 alumni impact analysis.[33] The likelihood of leaving the workforce increases as students age, so the attrition rate is more aggressive near the end of the time horizon than in the beginning. Column 4 of Table 3.4 shows the net higher earnings to students after Industrial Systems and Mechatronics Engineering Technology for both the settling-in patterns and attrition.

33 See the discussion of the alumni impact discussed in the previous section. 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.

Return on investment to students

Having estimated the students' costs and their future benefits stream for the Industrial Systems and Mechatronics Engineering Technology program's students, the next step is to discount the results to the present to reflect the time value of money. We assume a discount rate of 4.5% (see below). Because students tend to rely upon debt to pay for education—i.e. they are negative savers—their discount rate is based upon student loan interest rates.[34] In Appendix 2, we conduct a sensitivity analysis of this discount rate. 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 1.0, a rate of return that exceeds the discount rate, and a reasonably short payback period.

Discount rate

The discount rate is a rate of interest that converts future costs and benefits to present values. For example, $1,000 in higher earnings realized 30 years in the future is worth much less than $1,000 in the present. All future values must therefore be expressed in present value terms in order to compare them with investments (i.e., costs) made today. The selection of an appropriate discount rate, however, can become an arbitrary and controversial undertaking. As suggested in economic theory, the discount rate should reflect the investor's opportunity cost of capital, i.e., the rate of return one could reasonably expect to obtain from alternative investment schemes. In this study we assume a 4.5% discount rate from the student perspective and a 0.4% discount rate from the perspective of taxpayers.

In Table 3.4, the net higher earnings of students yield a cumulative discounted sum of approximately $285.3 thousand, the present value of all of the future earnings increments (see the bottom section of Column 4). This may also be interpreted as the gross capital asset value of the students' higher earnings stream. In effect, the aggregate FY 2019-20 student body is rewarded for its investment in R-CCC's Industrial Systems and Mechatronics Engineering Technology program with a capital asset valued at $285.3 thousand.

The Industrial Systems and Mechatronics Engineering Technology program's students' cost is shown in Column 5 of Table 3.4, equal to a present value of $14.5 thousand. Comparing the cost with the present value of benefits yields a student benefit-cost ratio of 19.7 (equal to $285.3 thousand in benefits divided by $14.5 thousand 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

34 The student discount rate is derived from the baseline forecasts for the 10-year Treasury rate published by the Congressional Budget Office. See the Congressional Budget Office, Student Loan and Pell Grant Programs—March 2020 Baseline. https://www.cbo.gov/system/files/2020-03/51310-2020-03-studentloan.pdf.

payments.[35] Table 3.4 shows students of the Industrial Systems and Mechatronics Engineering Technology program earning average returns of 29.2% on their investment of time and money. This is a favorable return compared, for example, to approximately 1% on a standard bank savings account, or 10% on stocks and bonds (30-year average return).

> R-CCC's Industrial Systems and Mechatronics Engineering Technology program students see an average rate of return of **29.2%** for their investment of time and money.

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% and a nominal percentage of 5% is paid, then the real rate of return on the investment is only 2%. In Table 3.4, the 29.2% student rate of return is a real rate. With an inflation rate of 2.1% (the average rate reported over the past 20 years as per the U.S. Department of Commerce, Consumer Price Index), the corresponding nominal rate of return is 31.2%, higher than what is reported in Table 3.4.

The payback period is defined as the length of time it takes to entirely recoup the initial investment.[36] Beyond that point, returns are what economists would call pure costless rent. As indicated in Table 3.4, students at R-CCC see, on average, a payback period of 5.5 years, meaning 5.5 years after their initial investment of foregone earnings and out-of-pocket costs, they will have received enough higher future earnings to fully recover those costs.

35 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.

36 Payback analysis is generally used by the business community to rank alternative investments when safety of investments is an issue. Its greatest drawback is it does not take into account 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.

TAXPAYER BENEFITS ANALYSIS

From the taxpayer perspective, the pivotal step is to determine the public benefits that specifically accrue to state government. For example, benefits resulting from earnings growth are limited to increased state tax payments. Similarly, savings related to improved health, reduced crime, and fewer welfare and unemployment claims, discussed below, are limited to those received strictly by state government. In all instances, benefits to private residents, local businesses, or the federal government are excluded.

TAXPAYER BENEFITS

Increased tax revenue

Avoided costs to state/local government

Growth in state tax revenues

As a result of their time in R-CCC's Industrial Systems and Mechatronics Engineering Technology program, students earn more because of the skills they learned while enrolled in the program, and businesses earn more because student skills make capital more productive (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. These in turn increase tax revenues since state government is able to apply tax rates to higher earnings.

Estimating the effect of R-CCC's Industrial Systems and Mechatronics Engineering Technology program on increased tax revenues begins with the present value of the students' future earnings stream, which is displayed in Column 4 of Table 3.4. To these net higher earnings, we apply a multiplier derived from Emsi Burning Glass's MR-SAM model to estimate the added labor income created in the state as students and businesses spend their higher earnings.[37] As labor income increases, so does non-labor 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 the North Carolina gross state product to total labor income in the state.

Not all of these tax revenues may be counted as benefits to the state, however. Some students leave the state during the course of their careers, and the higher

37 For a full description of the Emsi Burning Glass MR-SAM model, see Appendix 5.

earnings they receive as a result of their education leaves the state with them. To account for this dynamic, we combine program student settlement data[38] from the college with data on migration patterns from the Internal Revenue Service to estimate the number of students who will leave the state workforce over time.

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 and is designed to account for the counterfactual scenario where the Industrial Systems and Mechatronics Engineering Technology program does not exist. The assumption in this case is that any benefits generated by students who could have received an education even without the program cannot be counted as new benefits to taxpayers. For this analysis, we assume an alternative education variable of 15%, meaning that 15% of the Industrial Systems and Mechatronics Engineering Technology program student population would have generated benefits anyway even without the program. For more information on the alternative education variable, see Appendix 7.

After adjusting for attrition and alternative education opportunities, we calculate the present value of the future added tax revenues that occur in the state, equal to $106.1 thousand. 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. Given that the stakeholder in this case is the public sector, we use the discount rate of 0.4%. This is the real treasury interest rate recommended by the Office of Management and Budget (OMB) for 30-year investments, and in Appendix 2, we conduct a sensitivity analysis of this discount rate.[39]

Government savings

In addition to the creation of higher tax revenues to the state government, 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 to the government that otherwise would have been drawn from public resources absent the education provided by R-CCC. Government savings appear in Figure 3.2 and Table 3.5 and break down into three main categories: 1) health savings, 2) crime savings, and 3) income assistance savings. Health savings include avoided medical costs that would have otherwise been covered by state government. Crime savings consist of avoided costs to the justice system (i.e., police protection, judicial and legal, and corrections).

In addition to the creation of **higher tax revenues** to the state government, education is statistically associated with a variety of lifestyle changes that generate **social savings**.

38 Because RCCC was unable to provide settlement data, Emsi Burning Glass used estimates based on student origin.

39 Office of Management and Budget. "Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses." *Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in Percent).* Last modified November 2020. https://www.whitehouse.gov/wp-content/uploads/2020/12/discount-history.pdf.

Income assistance benefits comprise avoided costs due to the reduced number of welfare and unemployment insurance claims.

The model quantifies government 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, and income assistance at the national and state 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 from the program, will not have poor health, commit crimes, or demand income assistance. We dampen these results by the ability bias adjustment discussed earlier in the student perspective section and in Appendix 6 to account for factors (besides education) that influence individual behavior. We then multiply the marginal effects of education times the associated costs of health, crime, and income assistance.[40] Finally, we apply the same adjustments for attrition and alternative education to derive the net savings to the government. Total government savings appear in Figure 3.2 and sum to $6.1 thousand.

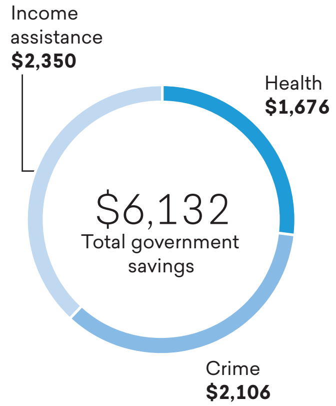
Table 3.5 displays all benefits to taxpayers. The first row shows the added tax revenues created in the state, equal to $106.1 thousand, from students' higher earnings and increases in non-labor income. The sum of the government savings and the added income in the state is $112.2 thousand, as shown in the bottom row of Table 3.5. These savings continue to accrue in the future as long as the FY 2019-20 student population of R-CCC remains in the workforce.

Table 3.5: PRESENT VALUE OF ADDED TAX REVENUE AND GOVERNMENT SAVINGS

Added tax revenue	**$106,053**
Government savings	
Health-related savings	$1,676
Crime-related savings	$2,106
Income assistance savings	$2,350
Total government savings	**$6,132**
Total taxpayer benefits	**$112,185**

Source: Emsi Burning Glass impact model.

Figure 3.2: PRESENT VALUE OF GOVERNMENT SAVINGS



Source: Emsi Burning Glass impact model.

40 For a full list of the data sources used to calculate the social externalities, see the Resources and References section. See also Appendix 9 for a more in-depth description of the methodology.

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APPENDIX 1: CIP TO SOC MAPPING

Industrial Systems and Mechatronics Engineering Technology (CIP 15.0499 & 15.0403)

Electrical & Electronic Engineering Technologists & Technicians (17-3023)

Electro-Mechanical & Mechatronics Technologists & Technicians (17-3024)

Calibration Technologists & Technicians & Engineering Technologists & Technicians, Except Drafters, All Other (17-3098)

Electrical & Electronics Repairers, Commercial & Industrial Equipment (49-2094)

Electrical, Electronic, & Electromechanical Assemblers, Except Coil Winders, Tapers, & Finishers (51-2028)

Criminal Justice Technology (CIP 43.0104)

Emergency Management Directors (11-9161)

Personal Service Managers, All Other; Entertainment & Recreation Managers, Except Gambling; & Managers, All Other (11-9198)

Compliance Officers (13-1041)

Project Management Specialists & Business Operations Specialists, All Other (13-1198)

Financial & Investment Analysts, Financial Risk Specialists, & Financial Specialists, All Other (13-2098)

Information Security Analysts (15-1212)

Child, Family, & School Social Workers (21-1021)

Probation Officers & Correctional Treatment Specialists (21-1092)

First-Line Supervisors of Correctional Officers (33-1011)

First-Line Supervisors of Police & Detectives (33-1012)

Fire Inspectors & Investigators (33-2021)

Bailiffs (33-3011)

Correctional Officers & Jailers (33-3012)

Detectives & Criminal Investigators (33-3021)

Police & Sheriffs Patrol Officers (33-3051)

Transit & Railroad Police (33-3052)

Private Detectives & Investigators (33-9021)

Public Safety Telecommunicators (43-5031)

Early Childhood Education (CIP 13.1210)

Education & Childcare Administrators, Preschool & Daycare (11-9031)

Education Administrators, Kindergarten through Secondary (11-9032)

Clinical, Counseling, & School Psychologists (19-3031)

Child, Family, & School Social Workers (21-1021)

Preschool Teachers, Except Special Education (25-2011)

Early Childhood Education (CIP 13.1210)
Kindergarten Teachers, Except Special Education (25-2012)
Elementary School Teachers, Except Special Education (25-2021)
Special Education Teachers, Preschool (25-2051)
Special Education Teachers, Kindergarten & Elementary School (25-2052)
Instructional Coordinators (25-9031)
Teaching Assistants, Except Postsecondary (25-9045)
Childcare Workers (39-9011)

Source: The link between CIPs and SOCs was provided by Emsi Burning Glass and reviewed by R-CCC. The program names listed are the names R-CCC uses internally and does not necessarily match the corresponding CIP codes that are provided by the National Center for Education Statistics.

APPENDIX 2: SENSITIVITY ANALYSIS

Sensitivity analysis measures the extent to which a model's outputs are affected by hypothetical changes in the background data and assumptions. This is especially important when those variables are inherently uncertain. This analysis allows us to identify a plausible range of potential results that would occur if the value of any of the variables is in fact different from what was expected. In this appendix we test the sensitivity of the model to the following input factors: 1) the alternative education variable, 2) the labor import effect variable, 3) the student employment variables, 4) and the discount rate.

Alternative education variable

The alternative education variable (15%) accounts for the counterfactual scenario where students would have to seek a similar education elsewhere absent the Industrial Systems and Mechatronics Engineering Technology program at the college in the region. Given the difficulty in accurately specifying the alternative education variable, we test the sensitivity of the taxpayer benefits analysis results to its magnitude. Variations in the alternative education assumption are calculated around base case results listed in the middle column of Table A2.1. Next, the model brackets the base case assumption on either side with a plus or minus 10%, 25%, and 50% variation in assumptions. Analyses are then repeated introducing one change at a time, holding all other variables constant. For example, an increase of 10% in the alternative education assumption (from 15% to 17%) reduces the taxpayer present value benefits from $112.2 thousand to $110.2 thousand. Likewise, a decrease of 10% (from 15% to 14%) in the assumption increases the present value benefits from $112.2 thousand to $114.2 thousand.

Table A2.1: SENSITIVITY ANALYSIS OF ALTERNATIVE EDUCATION VARIABLE

% variation in assumption	-50%	-25%	-10%	Base case	10%	25%	50%
Alternative education variable	8%	11%	14%	15%	17%	19%	23%
Present value taxpayer benefits (thousands)	$122	$117	$114	$112	$110	$107	$102

Based on this sensitivity analysis, the conclusion can be drawn that R-CCC's Industrial Systems and Mechatronics Engineering Technology program taxpayer benefits analysis results are not very sensitive to relatively large variations in the alternative education variable. The conclusion is that although the assumption is difficult to specify, its impact on taxpayer benefits is not very sensitive.

Labor import effect variable

The labor import effect variable only affects the alumni impact calculation in Table 3.2. In the model we assume a labor import effect variable of 50%, which means that 50% of the region's labor demands would have been satisfied without the presence of R-CCC. In other words, businesses that hired R-CCC students could have substituted some of these workers with equally qualified people from outside the region had there been no R-CCC students to hire. Therefore, we attribute only the remaining 50% of the initial labor income generated by increased alumni productivity to the program.

Table A2.2 presents the results of the sensitivity analysis for the labor import effect variable. As explained earlier, the assumption increases and decreases relative to the base case of 50% by the increments indicated in the table. Alumni productivity impacts attributable to R-CCC, for example, range from a high of $142.5 thousand at a -50% variation to a low of $47.5 thousand at a +50% variation from the base case assumption. This means that if the labor import effect variable increases, the impact that we claim as attributable to alumni decreases. Even under the most conservative assumptions, the alumni impact on the R-CCC Service Area economy remains sizeable.

Table A2.2: SENSITIVITY ANALYSIS OF LABOR IMPORT EFFECT VARIABLE

% variation in assumption	-50%	-25%	-10%	Base case	10%	25%	50%
Labor import effect variable	25%	38%	45%	50%	55%	63%	75%
Alumni impact (millions)	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.0

Student employment variables

Student employment variables are difficult to estimate because many students do not report their employment status or because colleges generally do not collect this kind of information. Employment variables include the following: 1) the percentage of students who are employed while enrolled in the program at the college and 2) the percentage of earnings that working students receive relative to the earnings they would have received had they not chosen to attend the college. Both employment variables affect the investment analysis results from the student perspective.

Students incur substantial expense by attending R-CCC because of the time they spend not gainfully employed. Some of that cost is recaptured if students remain partially (or fully) employed while attending. It is estimated that 75% of students are employed.[41] This variable is tested in the sensitivity analysis by changing it first to 100% and then to 0%.

41 Emsi Burning Glass provided an estimate of the percentage of students employed because R-CCC was unable to provide data. This figure excludes dual credit high school students, who are not included in the opportunity cost calculations.

The second student employment variable is more difficult to estimate. In this study we estimate that students who are working while enrolled in the Industrial Systems and Mechatronics Engineering Technology program at the college earn only 70%, on average, of the earnings that they statistically would have received if not attending R-CCC. This suggests that many students hold part-time jobs that accommodate their R-CCC attendance, though it is at an additional cost in terms of receiving a wage that is less than what they otherwise might make. The 70% variable is an estimation based on the average hourly wages of the most common jobs held by students while enrolled in the program at the 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 70% estimate is tested in the sensitivity analysis by changing it to 100% and then to 0%.

The changes generate results summarized in Table A2.3, 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 75% and *B* equal to 70%. Sensitivity analysis results are shown in non-shaded rows. Scenario 1 increases *A* to 100% while holding *B* constant, Scenario 2 increases *B* to 100% while holding *A* constant, Scenario 3 increases both *A* and *B* to 100%, and Scenario 4 decreases both *A* and *B* to 0%.

Table A2.3: SENSITIVITY ANALYSIS OF STUDENT EMPLOYMENT VARIABLES

Variations in assumptions	Net present value (millions)	Internal rate of return	Benefit-cost ratio
Base case: A = 75%, B = 70%	$0.3	29.2%	19.7
Scenario 1: A = 100%, B = 70%	$0.3	30.2%	21.2
Scenario 2: A = 75%, B = 100%	$0.3	30.6%	21.8
Scenario 3: A = 100%, B = 100%	$0.3	32.4%	24.6
Scenario 4: A = 0%, B = 0%	$0.3	26.6%	16.2

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

- **Scenario 1:** Increasing the percentage of students employed (A) from 75% to 100%, the net present value, internal rate of return, and benefit-cost ratio improve to $271.8 thousand, 30.2%, and 21.2, respectively, relative to base case results. Improved results are attributable to a lower opportunity cost of time; all students are employed in this case.
- **Scenario 2:** Increasing earnings relative to statistical averages (B) from 70% to 100%, the net present value, internal rate of return, and benefit-cost ratio results improve to $272.2 thousand, 30.6%, and 21.8, respectively, relative to base case results; a strong improvement, again attributable to a lower opportunity cost of time.

- **Scenario 3:** Increasing both assumptions *A* and *B* to 100% simultaneously, the net present value, internal rate of return, and benefit-cost ratio improve yet further to $273.7 thousand, 32.4%, and 24.6, 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.

- **Scenario 4:** Finally, decreasing both *A* and *B* to 0% reduces the net present value, internal rate of return, and benefit-cost ratio to $267.7 thousand, 26.6%, and 16.2, respectively, relative to base case results. These results are reflective of an increased opportunity cost; none of the students are employed in this case.[42]

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 R-CCC generate excellent returns, well above the long-term average percent rates of return in stock and bond markets.

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 forego the use of money in the present 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% discount rate for students and a 0.4% discount rate for taxpayers.[43] Similar to the sensitivity analysis of the alternative education variable, we vary the base case discount rates for students and taxpayers on either side by increasing the discount rate by 10%, 25%, and 50%, and then reducing it by 10%, 25%, and 50%. Note that, because the student rate of return and 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 for students and the present value for taxpayers are shown in Table A2.4.

42 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.

43 These values are based on the baseline forecasts for the 10-year Treasury rate published by the Congressional Budget Office and the real treasury interest rates recommended by the Office of Management and Budget for 30-year investments. See the Congressional Budget Office "Table 4. Projection of Borrower Interest Rates: CBO's March 2020 Baseline" and the Office of Management and Budget "Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses."

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% (from 4.5% to 6.8%) reduces the students' benefit-cost ratio from 19.7 to 14.6. Conversely, reducing the discount rate for students by 50% (from 4.5% to 2.3%) increases the benefit-cost ratio from 19.7 to 33.7. The sensitivity analysis results for taxpayers show the same inverse relationship between the discount rate and the benefits (from $118.3 thousand at a -50% variation from the base case to $106.5 thousand at a 50% variation from the base case).

Table A2.4: SENSITIVITY ANALYSIS OF DISCOUNT RATE

% variation in assumption	-50%	-25%	-10%	Base case	10%	25%	50%
Student perspective							
Discount rate	2.3%	3.4%	4.1%	4.5%	5.0%	5.7%	6.8%
Net present value (thousands)	$475	$355	$301	$271	$244	$210	$198
Benefit-cost ratio	33.7	25.5	21.8	19.7	17.8	15.4	14.6
Taxpayer perspective							
Discount rate	0.2%	0.3%	0.4%	0.4%	0.4%	0.5%	0.6%
Present value benefits (thousands)	$118	$115	$113	$112	$111	$109	$106

APPENDIX 3: 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 if the program under analysis did not exist. An estimate of 10%, for example, means that 10% of students do not depend directly on the existence of the program 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.

Counterfactual scenario: What would have happened if a given event had not occurred. In the case of this economic impact study, the counterfactual scenario is a scenario where the program did not exist.

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.

Earnings (labor income): Income that is received as a result of labor; i.e., wages.

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).

Externalities: Impacts (positive and negative) for which there is no compensation. Positive externalities of education include improved social behaviors such as improved health, lower crime, and reduced demand for income assistance. 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 regional product: Measure of the final value of all goods and services produced in a region after netting out the cost of goods used in production. Alternatively, gross regional product (GRP) 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. Gross regional product is also sometimes called value added or added income.

Initial effect: Income generated by the initial injection of monies into the economy through the higher earnings of its students.

Input-output analysis: Relationship between a given set of demands for final goods and services and the implied amounts of manufactured inputs, raw materials, and labor that this requires. When educational institutions pay wages and salaries and spend money for supplies in the region, they also generate earnings in all sectors of the economy, thereby increasing the demand for goods and services and jobs. Moreover, as students enter or rejoin the workforce with higher skills, they earn higher salaries and wages. In turn, this generates more consumption and spending in other sectors of the economy.

Internal rate of return: Rate of interest that, 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.

Multiplier effect: Additional income created in the economy as the program's its students spend money in the region. It consists of the income created by the supply chain of the industries initially affected by the spending of its 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).

NAICS: The North American Industry Classification System (NAICS) classifies North American business establishment in order to better collect, analyze, and publish statistical data related to the business economy.

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 foregone from alternative B once a decision is made to allocate resources to alternative A. Or, if individuals choose to attend the program, they forego earnings that they would have received had they chose instead to work full-time. Foregone earnings, therefore, are the "price tag" of choosing to enroll in the program at the 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 4: EXAMPLE OF SALES VERSUS INCOME

Emsi Burning Glass's economic impact study differs from many other studies because we prefer to report the impacts in terms of income rather than sales (or output). Income is synonymous with value added or gross regional product (GRP). Sales include all the intermediary costs associated with producing goods and services. Income is a net measure that excludes these intermediary costs:

Income = Sales – Intermediary Costs

For this reason, income is a more meaningful measure of new economic activity than reporting sales. This is evidenced by the use of gross domestic product (GDP)—a measure of income—by economists when considering the economic growth or size of a country. The difference is GRP reflects a region and GDP a country.

To demonstrate the difference between income and sales, let us consider an example of a baker's production of a loaf of bread. The baker buys the ingredients such as eggs, flour, and yeast for $2.00. He uses capital such as a mixer to combine the ingredients and an oven to bake the bread and convert it into a final product. Overhead costs for these steps are $1.00. Total intermediary costs are $3.00. The baker then sells the loaf of bread for $5.00.

The sales amount of the loaf of bread is $5.00. The income from the loaf of bread is equal to the sales amount less the intermediary costs:

Income = $5.00 − $3.00 = $2.00

In our analysis, we provide context behind the income figures by also reporting the associated number of jobs. The impacts are also reported in sales and earnings terms for reference.

APPENDIX 5: EMSI BURNING GLASS MR-SAM

Emsi Burning Glass's MR-SAM represents the flow of all economic transactions in a given region. It replaces Emsi Burning Glass's previous input-output (IO) model, which operated with some 1,000 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 MR-SAM model performs the same tasks as the old IO model, but it also does much more. Along with the same 1,000 industries, government, household and investment sectors embedded in the old IO tool, the MR-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 documentation on the technical aspects of the model is available upon request.

Data sources for the model

The Emsi Burning Glass 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 Burning Glass 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 Burning Glass MR-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 (also known as added income) 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 Burning Glass MR-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 Burning Glass 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.

Bureau of Labor Statistics Consumer Expenditure Survey (CEX) reports on the buying habits of consumers along with some information as to their income, consumer unit, and demographics. Emsi Burning Glass 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 Burning Glass 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 Burning Glass 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 Burning Glass's gravitational flows model that estimates the amount of trade between counties in the country.

Overview of the MR-SAM model

Emsi Burning Glass's MR-SAM modeling system is a comparative static 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 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 Burning Glass MR-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 model that shows year-by-year changes over time (as REMI's does).

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 flows between row and column sectors during a chosen base year. Read across rows, SAM entries show the flow of funds into column accounts (also known as receipts or the appropriation of funds by those column accounts). Read down columns, SAM entries show the flow of funds into row accounts (also known as 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 1,000 detailed accounts.

MULTI-REGIONAL ASPECT OF THE MR-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 of a collection of counties.

Emsi Burning Glass'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 Burning Glass'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.

Components of the Emsi Burning Glass MR-SAM model

The Emsi Burning Glass 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 Burning Glass's internally created data are used to a great extent throughout the processes described below, but its creation is not described in this appendix.

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 Burning Glass'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 are 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.

COMMUTING MODEL

The commuting sub-model is an integral part of Emsi Burning Glass'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 and place-of-work earnings. These data are created using Bureau of Labor Statistics' OnTheMap dataset, Census' Journey-to-Work, BEA's LPI CA91 and CA05 tables, and some of Emsi Burning Glass'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.

NATIONAL SAM

The national SAM as described above is made up of several different components. Many of the elements discussed are filled in with values from the national Z matrix—or industry-to-industry transaction 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.

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 Burning Glass uses a modification of the "diagonal similarity scaling" algorithm to balance the national SAM.

GRAVITATIONAL FLOWS MODEL

The most important piece of the Emsi Burning Glass MR-SAM model is the gravitational flows model that produces county-by-county regional purchasing coefficients (RPCs). RPCs estimate how much an industry purchases from other industries inside and outside of the defined region. This information is critical for calculating all IO models.

Gravity modeling starts with the creation of an impedance matrix that values the difficulty of moving a product from county to county. For each sector, an impedance matrix is created based on a set of distance impedance methods for that sector. A distance impedance method is one of the measurements reported in the Oak Ridge National Laboratory's County-to-County Distance Matrix. In this matrix, every county-to-county relationship is accounted for in six measures: great-circle distance, highway impedance, rail miles, rail impedance, water impedance, and highway-rail-highway impedance. Next, using the impedance information, the trade flows for each industry in every county are solved for. 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.

APPENDIX 6: VALUE PER CREDIT HOUR EQUIVALENT AND THE MINCER FUNCTION

Two key components in the analysis 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.

Value per CHE

Typically, the educational achievements of students are marked by the credentials they earn. However, not all students who enrolled in the Industrial Systems and Mechatronics Engineering Technology program at R-CCC in FY 2019-20 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 enrolled in the program at the college, 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 120 CHEs in order to move from a high school diploma to a bachelor's degree, another 60 CHEs to move from a bachelor's degree to a master'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 of 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.[44] For example, the difference in regional earnings between a high school diploma and an associate degree is $12,400. We spread this $12,400 wage differential across the 60 CHEs that occur between a high school diploma and an associate degree, applying a ceremonial "boost" to the last CHE in the stage to mark the achievement of the degree.[45] We repeat this process for each education level in the ladder.

44 The value per CHE is different between the economic impact analysis and the investment analysis. The economic impact analysis uses the region as its background and, therefore, uses regional earnings to calculate value per CHE, while the investment analysis uses the state as its backdrop and, therefore, uses state earnings. The methodology outlined in this appendix will use regional earnings; however, the same methodology is followed for the investment analysis when state earnings are used.

45 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 effect or signaling effect. The ceremonial boosts applied to the achievement of degrees in the Emsi Burning Glass impact model are derived from Jaeger and Page (1996).

Next, we map the CHE production of the FY 2019-20 student population to the education ladder. In total, students completed 130 CHEs during the analysis year. 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, bachelor's degree graduates are allocated to the stage between the associate degree and the bachelor'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:

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

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 A6.1 displays the result for the students' aggregate annual increase in income (ΔE), a total of $24 thousand. By dividing this value by the students' total production of 130 CHEs during the analysis year, we derive an overall value of $184 per CHE.

Table A6.1:
AGGREGATE ANNUAL INCREASE IN INCOME OF STUDENTS AND VALUE PER CHE

Aggregate annual increase in income	$23,977
Total credit hour equivalents (CHEs) in FY 2019-20	130
Value per CHE	**$184**

Source: Emsi Burning Glass impact model.

Mincer function

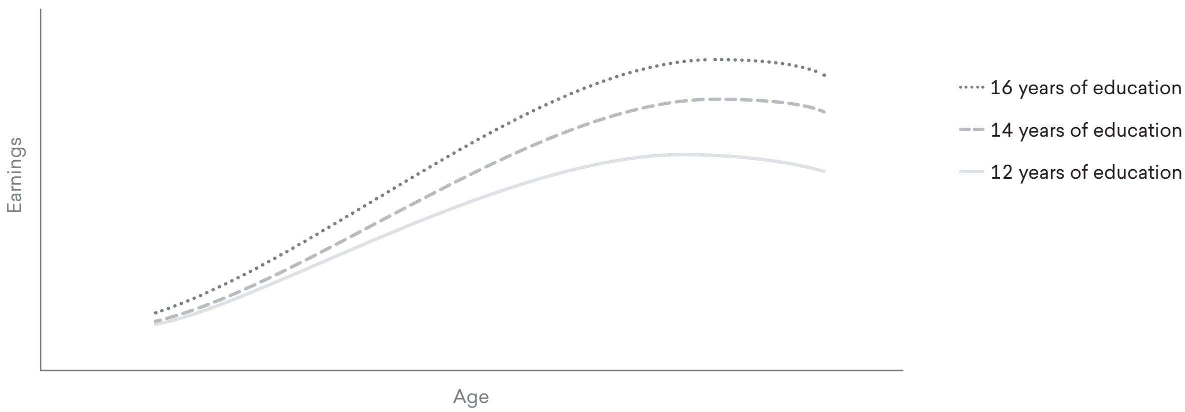
The $184 value per CHE in Table A6.1 only tells part of the story, however. Human capital theory holds that earnings levels do not remain constant; rather, they start relatively low and gradually increase as the worker gains more experience. Research also shows that the earnings increment between educated 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.[46] While some have criticized Mincer's earnings function, it is still upheld in recent data and has served as the foundation for a variety of research pertaining to labor economics. Those critical of the Mincer function point to several unobserved

46 See Mincer (1958 and 1974).

factors such as ability, socioeconomic status, and family background that also help explain higher earnings. Failure to account for these factors results in what is known as an "ability bias." Research by Card (1999 and 2001) suggests that the benefits estimated using Mincer's function are biased upwards by 10% or less. As such, we reduce the estimated benefits by 10%. We use state-specific and education level-specific Mincer coefficients.

Figure A6.1 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 A6.1: LIFECYCLE CHANGE IN EARNINGS



In calculating the alumni impact in Chapter 3, we use the slope of the curve in Mincer's earnings function to condition the $184 value per CHE to the students' age and work experience. To the students just starting their career during the analysis year, we apply a lower value per CHE; to the students in the latter half or approaching the end of their careers we apply a higher value per CHE. The original $184 value per CHE applies only to the CHE production of students precisely at the midpoint of their careers during the analysis year.

We again apply the Mincer function, this time to project the benefits stream of the FY 2019-20 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 A6.1.

APPENDIX 7: ALTERNATIVE EDUCATION VARIABLE

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

Recall this analysis considers only relevant economic information regarding the program. Considering the existence of various other academic institutions surrounding the college, we have to assume that a portion of the students could find alternative education and either remain in or return to the region. For example, some students may participate in online programs while remaining in the region. Others may attend an out-of-region institution and return to the region upon completing their studies. For these students—who would have found an alternative education and produced benefits in the region regardless of the presence of the program—we discount the benefits attributed to the program. An important distinction must be made here: the benefits from students who would find alternative education outside the region and not return to the region are not discounted. Because these benefits would not occur in the region without the presence of the program, they must be included.

In the absence of the program, we assume 15% of the program's students would find alternative education opportunities and remain in or return to the region. We account for this by discounting the alumni impact, the benefits to taxpayers by 15%. In other words, we assume 15% of the benefits created by the program's students would have occurred anyway in the counterfactual scenario where the program did not exist. A sensitivity analysis of this adjustment is presented in Appendix 1.

APPENDIX 8: OVERVIEW OF INVESTMENT ANALYSIS MEASURES

The appendix provides context to the investment analysis results using the simple hypothetical example summarized in Table A8.1 below. The table shows the projected benefits and costs for a single student over time and associated investment analysis results.[47]

Table A8.1: EXAMPLE OF THE BENEFITS AND COSTS OF EDUCATION FOR A SINGLE STUDENT

1	2	3	4	5	6
Year	**Tuition**	**Opportunity cost**	**Total cost**	**Higher earnings**	**Net cash flow**
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**

Benefit-cost ratio	Internal rate of return	Payback period (years)
1.7	18.0%	4.2

Assumptions are as follows:

- Benefits and costs are projected out 10 years into the future (Column 1).
- The student attends the college for one year, and the cost of tuition is $1,500 (Column 2).
- Earnings foregone while attending the college for one year (opportunity cost) come to $20,000 (Column 3).
- Together, tuition and earnings foregone cost sum to $21,500. This represents the out-of-pocket investment made by the student (Column 4).

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

- In return, the student earns $5,000 more per year than he otherwise would have earned without the education (Column 5).
- The net cash flow (NCF) in Column 6 shows higher earnings (Column 5) less the total cost (Column 4).
- The assumed going rate of interest is 4%, the rate of return from alternative investment schemes for the use of the $21,500.

Results are expressed in standard investment analysis terms, which are as follows: the net present value, 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 A8.1.

Net present value

The student in Table A8.1 can choose either to attend college or to forego 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 earnings 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 A8.1, 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 foregone) 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.[48]

Let us take a brief example. At 4%, the present value of $5,000 to be received one year from today is $4,807. If the $5,000 were to be received in year 10, the present value would reduce to $3,377. Put another way, $4,807 deposited in the bank today earning 4% interest will grow to $5,000 in one year; and $3,377 deposited today would grow to $5,000 in 10 years. An "economically rational" person would, therefore, be equally satisfied receiving $3,377 today or $5,000 10 years from today given the going rate of interest of 4%. The process of discounting—finding the present value of future higher earnings—allows the model to express values on an equal basis in future or present value terms.

48 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 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 foregone). As indicated in Table A8.1 the cumulative present value of $5,000 worth of higher earnings between years 2 and 10 is $35,753 given the 4% interest rate, far lower than the undiscounted $45,000 discussed above.

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.

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 A8.1. 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% 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% in fact, as indicated in Table A8.1. Or, if a discount rate of 18.0% were applied to the net present value calculations instead of the 4%, then the net present value would reduce to zero.

What does this mean? The internal rate of return of 18.0% defines a breakeven solution—the point where the present value of benefits just equals the present value of costs, or where the net present value equals zero. Or, at 18.0%, higher earnings of $5,000 per year for the next nine years will earn back all investments of $21,500 made plus pay 18.0% for the use of that money ($21,500) in the meantime. Is this a good return? Indeed, it is. If it is compared to the 4% going rate of interest applied to the net present value calculations, 18.0% is far higher than 4%. It may be concluded, therefore, that the investment in this case is solid. Alternatively, comparing the 18.0% rate of return to the long-term 10% 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).

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% discount rate). Of course, any change in the discount rate would also change the benefit-cost ratio. Applying the 18.0% internal rate of return discussed above would reduce the benefit-cost ratio to 1.0, the breakeven solution where benefits just equal costs.

Applying a discount rate higher than the 18.0% would reduce the ratio to lower than 1.0, and the investment would not be feasible. The 1.7 ratio means that a dollar invested today will return a cumulative $1.70 over the ten-year time period.

Payback period

This is the length of time from the beginning of the investment (consisting of tuition and earnings foregone) until higher future earnings give a return on the investment made. For the student in Table A8.1, 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 foregone while attending the 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 9: 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 communities and citizens throughout the region, including taxpayers. In this appendix we discuss the following three main benefit categories: 1) improved health, 2) reductions in crime, and 3) reduced demand for government-funded income assistance.

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

Health

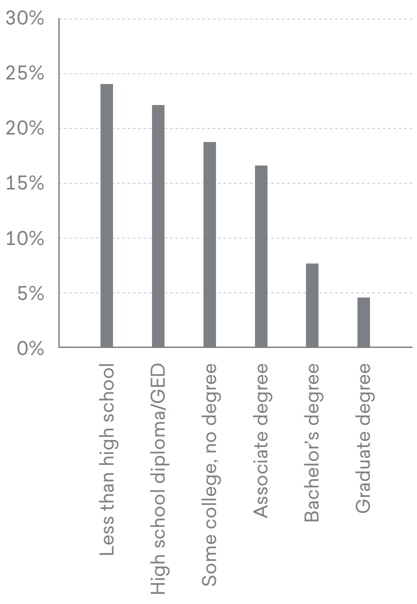
Statistics show a correlation between increased education and improved health. The manifestations of this are found in five health-related variables: smoking, alcohol dependence, obesity, depression, and drug abuse. There are other health-related areas that link to educational attainment, but these are omitted from the analysis until we can invoke adequate (and mutually exclusive) databases and are able to fully develop the functional relationships between them.

SMOKING

Despite a marked decline over the last several decades in the percentage of U.S. residents who smoke, a sizeable percentage of the U.S. population still smokes. 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 A9.1 shows the prevalence of cigarette smoking among adults, 25 years and over, based on data provided by the National Health Interview Survey.[49] The data include adults who reported smoking more than 100 cigarettes during their lifetime and who, at the time of interview, reported smoking every day or some days. As indicated, the percent of who smoke begins to decline beyond the level of high school education.

Figure A9.1: PREVALENCE OF SMOKING AMONG U.S. ADULTS BY EDUCATION LEVEL



Source: Centers for Disease Control and Prevention.

49 Centers for Disease Control and Prevention. "Table. Characteristics of current adult cigarette smokers," National Health Interview Survey, United States, 2016.

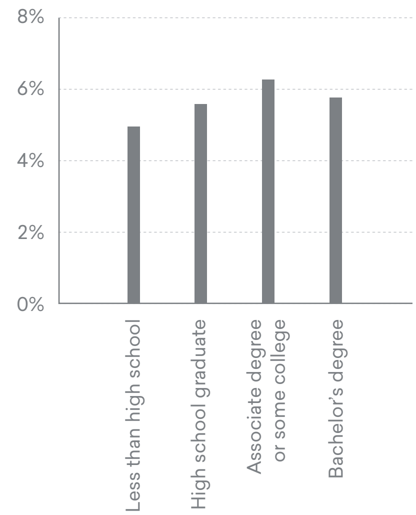
The Centers for Disease Control and Prevention (CDC) reports the percentage of adults who are current smokers by state.[50] We use this information to create an index value by which we adjust the national prevalence data on smoking to each state. For example, 17.4% of North Carolina adults were smokers in 2018, relative to 15.9% for the nation. We thus apply a scalar of 1.09 to the national probabilities of smoking in order to adjust them to the state of North Carolina.

ALCOHOL DEPENDENCE

Although alcohol dependence has large public and private costs, it is difficult to measure and define. There are many patterns of drinking, ranging from abstinence to heavy drinking. Alcohol abuse is riddled with social costs, including health care expenditures for treatment, prevention, and support; workplace losses due to reduced worker productivity; and other effects.

Figure A9.2 compares the percentage of adults, 18 and older, that abuse or depend on alcohol by education level, based on data from the Substance Abuse and Mental Health Services Administration (SAMHSA).[51] These statistics give an indication of the correlation between education and the reduced probability of alcohol dependence. Adults with an associate degree or some college have higher rates of alcohol dependence than adults with a high school diploma or lower. Prevalence rates are lower for adults with a bachelor's degree or higher than those with an associate degree or some college. Although the data do not maintain a pattern of decreased alcohol dependence at every level of increased education, we include these rates in our model to ensure we provide a comprehensive view of the social benefits and costs correlated with education.

Figure A9.2: PREVALENCE OF ALCOHOL DEPENDENCE OR ABUSE BY EDUCATION LEVEL



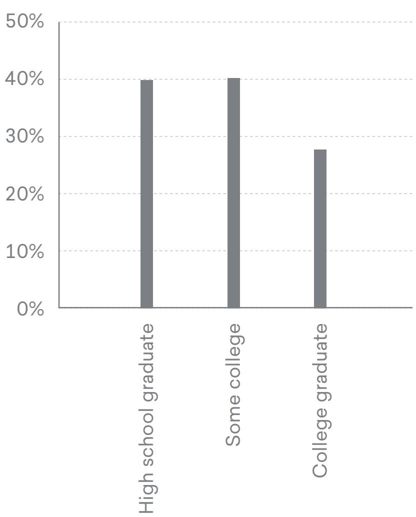
Source: Centers for Disease Control and Prevention.

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.[52]

Data for Figure A9.3 is derived from the National Center for Health Statistics which shows the prevalence of obesity among adults aged 20 years and over by education, gender, and ethnicity.[53] As indicated, college graduates are less likely to be obese than individuals with a high school diploma. However, the

Figure A9.3: PREVALENCE OF OBESITY BY EDUCATION LEVEL



Source: Derived from data provided by the National Center for Health Statistics.

50 Centers for Disease Control and Prevention. "Current Cigarette Use Among Adults (Behavior Risk Factor Surveillance System) 2018." *Behavioral Risk Factor Surveillance System Prevalence and Trends Data*, 2018.

51 Substance Abuse and Mental Health Services Administration. "Table 5.4B—Alcohol Use Disorder in Past Year among Persons Aged 12 or Older, by Age Group and Demographic Characteristics: Percentages, 2017 and 2018." SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2017 and 2018.

52 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.

53 Ogden Cynthia L., Tala H. Fakhouri, Margaret D. Carroll, Craig M. Hales, Cheryl D. Fryar, Xianfen Li, David S. Freedman. "Prevalence of Obesity Among Adults, by Household Income and Education—United States, 2011–2014" National Center for Health Statistics, *Morbidity and Mortality Weekly Report*, 66:1369–1373 (2017).

prevalence of obesity among adults with some college is actually greater than those with just a high school diploma. In general, though, obesity tends to decline with increasing levels of education.

DEPRESSION

Capturing the full economic cost of mental illness is difficult because not all mental disorders have a correlation with education. For this reason, we only examine the economic costs associated with major depressive disorder (MDD), which are comprised of medical and pharmaceutical costs, workplace costs such as absenteeism, and suicide-related costs.[54]

Figure A9.4 summarizes the prevalence of MDD among adults by education level, based on data provided by the CDC.[55] As shown, people with some college are most likely to have MDD compared to those with other levels of educational attainment. People with a high school diploma or less, along with college graduates, are all fairly similar in the prevalence rates.

DRUG ABUSE

The burden and cost of illicit drug abuse is enormous in the U.S., but little is known about the magnitude of costs and effects at a national 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 3.9%, twice as large as the probability of drug abuse for college graduates (1.7%). This relationship is presented in Figure A9.5 based on data supplied by SAMHSA.[56] Similar to alcohol abuse, prevalence does not strictly decline at every education level. Health costs associated with illegal drug use are also available from SAMSHA, with costs to state government representing 40% of the total cost related to illegal drug use.[57]

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

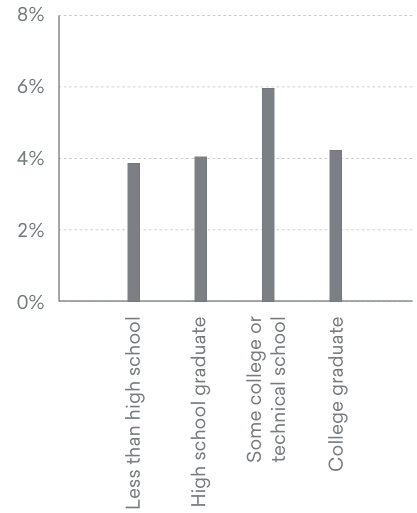
54 Greenberg, Paul, Andree-Anne Fournier, Tammy Sisitsky, Crystal Pike, and Ronald Kesslaer. “The Economic Burden of Adults with Major Depressive Disorder in the United States (2005 and 2010)” *Journal of Clinical Psychiatry* 76:2, 2015.

55 National Survey on Drug Use and Health. “Table 8.40B: Major Depressive Episode (MDE) or MDE with Severe Impairment in Past Year among Persons Aged 18 or Older, and Receipt of Treatment for Depression in Past Year among Persons Aged 18 or Older with MDE or MDE with Severe Impairment in Past Year, by Geographic, Socioeconomic, and Health Characteristics: Numbers in Thousands, 2017 and 2018.”

56 Substance Abuse and Mental Health Services Administration. “Table 5.3B—Illicit Drug Use Disorder in Past Year among Persons Aged 12 or Older, by Age Group and Demographic Characteristics: Percentages, 2017 and 2018.” SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2017 and 2018.

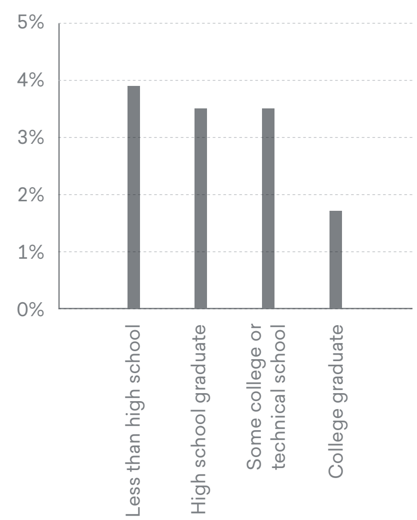
57 Substance Abuse and Mental Health Services Administration. “Table A.2. Spending by Payer: Levels and Percent Distribution for Mental Health and Substance Abuse (MHSA), Mental Health (MH), Substance Abuse (SA), Alcohol Abuse (AA), Drug Abuse (DA), and All-Health, 2014.” *Behavioral Health Spending & Use Accounts, 1986–2014. HHS Publication No. SMA-16-4975, 2016.*

Figure A9.4: PREVALENCE OF MAJOR DEPRESSIVE EPISODE BY EDUCATION LEVEL



Source: National Survey on Drug Use and Health.

Figure A9.5: PREVALENCE OF ILLICIT DRUG DEPENDENCE OR ABUSE BY EDUCATION LEVEL



Source: Substance Abuse and Mental Health Services Administration.

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 A9.6 displays the educational attainment of the incarcerated population in the U.S. Data are derived from the breakdown of the inmate population by education level in federal, state, and local prisons as provided by the U.S. Census Bureau.[58]

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.[59]

Yet another measurable cost is the economic productivity of people who are incarcerated and are thus not employed. The measurable productivity cost is simply the number of additional incarcerated people, who could have been in the labor force, multiplied by the average income of their corresponding education levels.

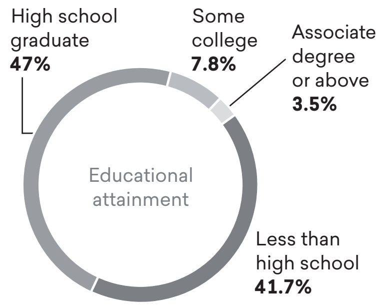
Income assistance

Statistics show that as education levels increase, the number of applicants for government-funded income assistance such as welfare and unemployment benefits 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.[60]

Figure A9.7 relates the breakdown of TANF recipients by education level, derived from data provided by the U.S. Department of Health and Human Services.[61] 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.

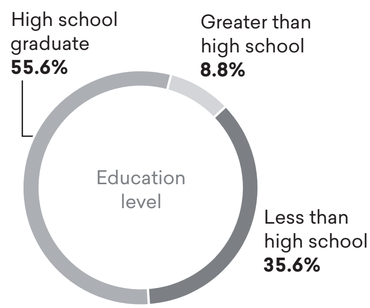
Unemployment rates also decline with increasing levels of education, as illustrated in Figure A9.8. These data are provided by the Bureau of Labor Statistics.[62] As shown, unemployment rates range from 5.4% for those with less than a high school diploma to 1.9% for those at the graduate degree level or higher.

Figure A9.6:
EDUCATIONAL ATTAINMENT OF THE INCARCERATED POPULATION



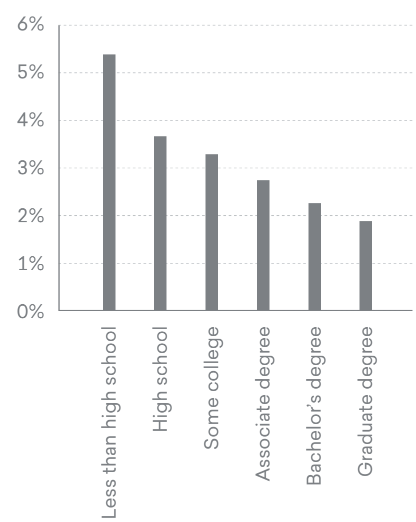
Source: Derived from data provided by the U.S. Census Bureau.

Figure A9.7:
BREAKDOWN OF TANF RECIPIENTS BY EDUCATION LEVEL



Source: U.S. Department of Health and Human Services, Office of Family Assistance.

Figure A9.8: UNEMPLOYMENT BY EDUCATION LEVEL



Source: Bureau of Labor Statistics.

58 U.S. Census Bureau. "Educational Characteristics of Prisoners: Data from the ACS." 2011.

59 McCollister, Kathryn E., 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 2010): 98-109.

60 Medicaid is not considered in this analysis because it overlaps with the medical expenses in the analyses for smoking, alcohol dependence, obesity, depression, and drug abuse. We also exclude any welfare benefits associated with disability and age.

61 U.S. Department of Health and Human Services, Office of Family Assistance. "Characteristics and Financial Circumstances of TANF Recipients, Fiscal Year 2018."

62 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, Household Data Annual Averages, 2019.