DEMONSTRATING THE COLLECTIVE ECONOMIC VALUE OF THE UNIVERSITY OF NORTH CAROLINA SYSTEM

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UNIVERSITY OF NORTH CAROLINA

CONTENTS

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EXECUTIVE SUMMARY

The purpose of this report is to assess the collective impact of the University of North Carolina (UNC) system on the state economy and the benefits generated by the universities for students, society, and taxpayers. The results of this study show that the UNC system creates a positive net impact on the state economy and the universities generate a positive return on investment for students, society, and taxpayers.

ECONOMIC IMPACT ANALYSIS

During the analysis year, UNC universities and the UNC Hospitals and Faculty Physicians (UNC Medical Center) spent **$5.3 billion** on payroll and benefits for **74,079** full-time and part-time employees, and spent another **$3.6 billion** on goods and services to carry out their day-to-day operations and research. This initial round of spending creates more spending across other businesses throughout the state economy, resulting in the commonly referred to multiplier effects. This analysis estimates the net economic impact of UNC universities and the UNC Medical Center that directly takes into account the fact that state and local dollars spent on UNC universities could have been spent elsewhere in the state if not directed towards UNC universities and would have created impacts regardless. We account for this by estimating the impacts that would have been created from the alternative spending and subtracting the alternative impacts from the spending impacts of UNC universities.

This analysis shows that in FY 2012-13, payroll and operations spending of UNC universities and the UNC Medical Center, together with the spending of their students, visitors, alumni, and start-up companies, created **$27.9 billion** in added state income to the North Carolina economy. Although we use terminology *added state income* to refer to the economic impacts, it is helpful to realize that state income in this context is equivalent to the commonly referred to measure of Gross State Product. The added state income, or additional Gross State Product, of **$27.9 billion** created by UNC universities and the UNC Medical Center is equal to approximately **6.4%** of the total Gross State Product of North Carolina, and is equivalent to creating **426,052** new jobs. These economic impacts break down as follows:

Operations spending impact

Payroll to support day-to-day operations (less clinical, research, and extension) of UNC universities amounted to **$3.5 billion**. The net impact of the universities' operations spend-

ing in North Carolina during the analysis year was approximately **$3.9 billion** in added state income, which is equivalent to creating **54,832** new jobs.

Clinical spending impact

In FY 2012-13, the UNC Medical Center and East Carolina University Health Sciences spent **$1.1 billion** on clinical and hospital faculty and staff to support their operations in North Carolina. The total net impact of these clinical and hospital operations in the state was **$2.3 billion** in added state income, which is equivalent to creating **27,759** new jobs.

Research spending impact

Research activities of UNC universities impact the state economy by employing people and making purchases for equipment, supplies, and services. They also facilitate new knowledge creation throughout North Carolina through inventions, patent applications, and licenses. In FY 2012-13, UNC universities spent **$717.2 million** on payroll to support research activities.

Research spending of UNC universities generates **$1.5 billion** in added state income for the North Carolina economy, which is equivalent to creating **22,094** new jobs.

Construction spending impact

UNC universities spend millions of dollars on construction each year to maintain their facilities, create additional capacities, and meet their growing educational demands. While the amount varies from year to year, these quick infusions of income and jobs have a substantial impact on the state economy. In FY 2012-13, the construction spending of UNC universities created **$173.1 million** in added state income, which is equivalent to creating **6,349** new jobs.

Business start-up impact

UNC universities create an exceptional environment that fosters innovation and entrepreneurship, evidenced by the number of start-up companies related to UNC universities created in the state. In FY 2012-13, start-up companies related to UNC universities created **$1.4 billion** in added state income for the North Carolina economy, which is equivalent to creating **7,712** jobs.

Extension spending impact

The North Carolina Cooperative Extension Service is a partnership between North Carolina State University and North Carolina A&T State University. Its purpose is to provide education and technology to help address the needs and

NOTE OF IMPORTANCE

There is an important point to consider when reviewing the impacts estimated in this study. Impacts are reported in the form of income rather than output. Output includes all the intermediary costs associated with producing goods and services. Income, on the other hand, is a net measure that excludes these intermediary costs and is synonymous with gross state product. For this reason, it is a more meaningful measure of new economic activity than output.

local problems of the state's diverse communities. North Carolina State University also operates an Industrial Extension Service program that caters to North Carolina's industries and businesses.

In FY 2012-13, these universities and their partner counties spent **$78.3 million** to support extension services, adding **$112.1 million** in state income for the North Carolina economy. This is equivalent to creating **1,459** new jobs.

Student spending impact

Around **19%** of graduate and undergraduate students attending UNC universities originated from outside the state. Some of these students relocated to North Carolina and spent money on groceries, transportation, rent, and so on at state businesses.

The expenditures of students who relocated to the state during the analysis year added approximately **$293.6 million** in state income for the North Carolina economy, which is equivalent to creating **5,377** new jobs.

Visitor spending impact

Out-of-state visitors attracted to North Carolina for activities at UNC universities brought new dollars to the economy through their spending at hotels, restaurants, gas stations, and other state businesses.

Visitor spending added approximately **$253.4 million** in state income for the North Carolina economy, which is equivalent to creating **6,474** new jobs.

Alumni impact

Over the years, students gained new skills, making them more productive workers, by studying at UNC universities. Today, hundreds of thousands of these former students are employed in North Carolina.

The accumulated contribution of former students currently employed in the North Carolina workforce amounted to **$17.9 billion** in state income added to the North Carolina economy, which is equivalent to creating **293,995** new jobs.

INVESTMENT ANALYSIS

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

Student perspective

Students invest their own money and time in their education. Students enrolled at UNC universities paid a total of **$1.7 billion** to cover the cost of tuition, fees, books, and supplies at UNC universities in FY 2012-13. They also forwent **$4.5 billion** in earnings that they would have generated had they been working instead of learning. In return, students will receive a present value of **$19.2 billion** in increased earnings over their working lives. This translates to a return of **$3.10** in higher future income for every $1 that students pay for their education at UNC universities. The corresponding annual rate of return is **13.7%**.

Societal perspective

North Carolina as a whole spent **$11.9 billion** on educations at UNC universities in FY 2012-13. This includes **$7.2 billion** in expenses by UNC universities (excluding clinical), **$226.8 million** in student expenses, and **$4.5 billion** in student opportunity costs. In return, the state of North Carolina will receive a present value

of **$93.1 billion** in added state income over the course of the students' working lives. North Carolina will also benefit from **$13.6 billion** in present value social savings related to reduced crime, lower welfare and unemployment, and increased health and well-being across the state. For every dollar society invests in an education from UNC universities, an average of **$8.90** in benefits will accrue to North Carolina over the course of the students' careers.

Taxpayer perspective

Taxpayers provided **$2.9 billion** of state and local funding (excluding clinical) to UNC universities in FY 2012-13. In return, taxpayers will receive a present value of **$9 billion** in added tax revenue stemming from the students' higher lifetime incomes and the increased output of businesses amounts. Savings to the public sector add another **$2.4 billion** in benefits due to a reduced demand for government-funded social services in North Carolina. For every taxpayer dollar spent on educations from UNC universities, taxpayers will receive an average of **$3.90** in return over the course of the students' working lives. In other words, taxpayers enjoy an annual rate of return of **11.8%**.

INTRODUCTION

This study considers the 16 university campuses and other entities of the University of North Carolina (UNC) system.[1] Throughout this report, we refer to the university campuses as UNC universities.[2] While the universities may have very different missions, they all have an important impact on the students they serve. They help students achieve their individual potential and develop the skills they need in order to have a fulfilling and prosperous career. However, the impact of UNC universities consists of more than influencing the lives of students. The universities' program offerings supply employers with workers to make their businesses more productive. The spending of the universities and their employees, students, and visitors support the state economy through the output and employment generated by state vendors. The benefits created by the universities extend as far as the state treasury in terms of the increased tax receipts and decreased public sector costs generated by students across the state.

1 The UNC system also includes the North Carolina School of Science and Mathematics, the North Carolina Arboretum, UNC Public Television, along with other affiliated entities. This study only evaluates the economic impact of the UNC system's16 universities, along with the clinical activities of the UNC Medical Center and East Carolina University Division of Health Sciences.

2 Please refer to Appendix 1 for a list of the member universities.

The purpose of this report is to assess the collective impact of the UNC system on the state economy and the benefits generated by the universities for students, society, and taxpayers. The approach is twofold. We begin with an economic impact analysis that measures the impacts generated by the universities on the North Carolina economy. To derive results, we rely on a specialized Social Accounting Matrix (SAM) model to calculate the additional income and jobs created in the North Carolina economy as a result of increased consumer spending and the added knowledge, skills, and abilities of students. Results of the economic impact analysis are broken out according to the following impacts:

1. Impact of **operations spending**
2. Impact of **spending on clinical services**
3. Impact of **spending on research and development**
4. Impact of **spending on construction**
5. Impact of **start-up companies** (with an additional assessment of spin-off companies)
6. Impact of **spending on extension services**
7. Impact of **student spending**
8. Impact of **visitor spending**
9. Impact of **alumni** employed in the North Carolina workforce.

The second component of the study measures the benefits generated by the UNC system for the following stakeholder groups: students, taxpayers, and society. For students, we perform an investment analysis to determine how the money spent by students on their education performs as an investment over time. The students' investment in this case consists of their out-of-pocket expenses and the opportunity cost of attending the universities as opposed to working. In return for these investments, students receive a lifetime of higher incomes. For taxpayers, the study measures the benefits to state taxpayers in the form of increased tax revenues and public sector savings stemming from a reduced demand for social services. Finally, for society, the study assesses how the students' higher incomes and improved quality of life create benefits throughout North Carolina as a whole.

A wide array of data are used in the study based on several sources, including the 2012-13 IPEDS academic and financial reports from UNC universities, industry and employment data from the U.S. Bureau of Labor Statistics and U.S. Census Bureau, outputs of EMSI's education impact model, outputs of EMSI's SAM model, and a variety of published materials relating education to social behavior.

CHAPTER 1
THE UNC SYSTEM AND THE ECONOMY

The study uses two general types of information: 1) data collected from the institutions and 2) state economic data obtained from various public sources and EMSI's proprietary data modeling tools.[3] This section presents the basic underlying institutional information used in this analysis and provides an overview of the North Carolina economy.

1.1 EMPLOYEE AND FINANCIAL DATA FOR THE UNC SYSTEM

1.1.1 Employee data

Data provided by the UNC system include information on faculty and staff by place of work and by place of residence. These data appear in Table 1.1. As shown, the UNC system employed 53,713 full-time and 20,366 part-time faculty and staff in FY 2012-13. These headcounts include student workers as well as faculty and staff involved in research, clinical, and extension operations. Of these, 100% worked in the state and 97% lived in the state. These data are used to isolate the portion of the employees' payroll and household expenses that remains in the state economy.

TABLE 1.1: EMPLOYEE DATA, FY 2012-13

Full-time faculty and staff	53,713
Part-time faculty and staff	20,366
Total faculty and staff	**74,079**
% of employees that work in state	100%
% of employees that live in state	97%

Source: Data supplied by UNC universities.

1.1.2 Revenues

Table 1.2 shows the universities' annual revenues by funding source – totaling $9.4 billion in FY 2012-13. These include revenues for general activities as well as for research, clinical, and extension activities. As indicated, tuition and fees comprised 15% of total revenue, and student aid from local, state, and federal government sources comprised another 46%. All other revenue (i.e., auxiliary revenue, sales and services, interest, and donations) comprised

3 See the Resources and References section for a detailed description of the data sources used in the EMSI modeling tools.

the remaining 39%. These data are critical in identifying the annual costs of educating the student body from the perspectives of students, society, and taxpayers.

1.1.3 Expenses

The combined payroll at the UNC system, including student salaries and wages as well as research, clinical, and extension activities, amounted to $5.3 billion. This was equal to 60% of the universities' total expenses for FY 2012-13. Other expenses, including capital and purchases of supplies and services, made up $3.6 billion. These budget data appear in Table 1.3. Excluded from the table are construction expenditures given that construction funding is separate from operations funding in the budgeting process.

1.1.4 Students

In the 2012-13 reporting year, UNC universities served 257,427 students taking courses for credit towards a degree. This number represents an unduplicated student headcount. The universities also served 1,021,266 registrations for courses not for credit towards a degree. Given data tracking limitations, the registrations do not necessarily represent an unduplicated student headcount. The breakdown of the credit-bearing student body by gender was 51% male and 49% female. The breakdown by ethnicity was 67% white, 30% minority, and 3% unknown. The students' overall average age was 24 years old.[4] An estimated 84% of students remain in North Carolina after finishing their time at UNC universities, and the remaining 16% settle outside the state.[5]

4 Unduplicated headcount, gender, ethnicity, and age data provided by UNC universities.

5 Settlement data provided by UNC universities. In the event that the data was unavailable, EMSI used estimates based on student origin.

TABLE 1.2: REVENUE BY SOURCE, FY 2012-13

FUNDING SOURCE	TOTAL	% OF TOTAL
Tuition and fees	$1,434,031,165	15%
Local government	$249,860,130	3%
State government*	$2,721,772,368	29%
Federal government	$1,302,134,878	14%
All other revenue	$3,658,094,001	39%
Total revenues	**$9,365,892,543**	**100%**

** Revenue from state government includes capital appropriations.*
Source: Data supplied by UNC universities.

TABLE 1.3: EXPENSES BY FUNCTION, FY 2012-13

EXPENSE ITEM	TOTAL	%
Salaries, wages, and benefits	$5,343,720,826	60%
Capital depreciation	$559,982,197	6%
All other expenses	$3,052,363,918	34%
Total expenses	**$8,956,066,941**	**100%**

Source: Data supplied by UNC universities.

Table 1.4 summarizes the breakdown of the student population and their corresponding awards and credits by education level. In FY 2012-13, UNC universities served 2,423 PhD or professional graduates, 11,322 master's degree graduates, 35,693 bachelor's degree graduates, 91 associate's degree graduates, and 1,061 certificate graduates. Another 202,376 students enrolled in courses for credit but did not complete a degree during the reporting year. The universities offered dual credit courses to high school students, serving a total of 4,461 students over the course of the year. There were around 169,521 non-degree-seeking registrations for basic education courses. The universi-

TABLE 1.4: BREAKDOWN OF STUDENT HEADCOUNT AND CHE PRODUCTION BY EDUCATION LEVEL, FY 2012-13

CATEGORY	HEADCOUNT	TOTAL CHEs	AVERAGE CHEs
DEGREE-SEEKING STUDENTS			
PhD or professional graduates	2,423	36,383	15.0
Master's degree graduates	11,322	143,001	12.6
Bachelor's degree graduates	35,693	758,339	21.2
Associate's degree graduates	91	1,823	20.0
Certificate graduates	1,061	9,249	8.7
Credit-bearing students not yet graduated	202,376	4,911,203	24.3
Dual credit students	4,461	47,408	10.6
Total, degree-seeking students	**257,427**	**5,907,405**	**22.9**
NON-DEGREE-SEEKING STUDENTS*			
Basic education students	169,521	451,525	2.7
Personal enrichment students	374,757	143,041	0.4
Workforce and all other students	476,988	337,911	0.7
Total, non-degree-seeking students	**1,021,266**	**932,478**	**0.9**
Total, all students	1,278,693	6,839,883	5.3
Total, less personal enrichment students	**903,936**	**6,696,841**	**7.4**

** Data reflect registrations which may include duplication of students due to limitations in tracking the data.*
Source: Data supplied by UNC universities.

ties also served 374,757 personal enrichment registrations in non-credit courses for leisure. Students not allocated to the other categories – including non-degree-seeking workforce students – comprised the remaining 476,988 registrations.

We use credit hour equivalents (CHEs) to track the educational workload of the students. One CHE is equal to 15 contact hours of classroom instruction per semester. In the analysis, we exclude the CHE production of personal enrichment students under the assumption that they do not attain knowledge, skills, and abilities that will increase their earnings. The average number of CHEs per student (excluding personal enrichment students) was 7.4.

1.2 THE NORTH CAROLINA ECONOMY

Table 1.5 on the next page summarizes the breakdown of the state economy by major industrial sector, 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-

TABLE 1.5: LABOR AND NON-LABOR INCOME BY MAJOR INDUSTRY SECTOR IN NORTH CAROLINA, 2013*†

INDUSTRY SECTOR	LABOR INCOME (MILLIONS)	+	NON-LABOR INCOME (MILLIONS)	=	TOTAL ADDED INCOME (MILLIONS)	OR	% OF TOTAL
Agriculture, Forestry, Fishing, and Hunting	$2,362		$1,550		$3,912		0.9%
Mining	$336		$657		$993		0.2%
Utilities	$1,415		$5,135		$6,551		1.5%
Construction	$11,680		$1,057		$12,738		2.9%
Manufacturing	$29,965		$38,734		$68,699		15.7%
Wholesale Trade	$13,161		$12,106		$25,268		5.8%
Retail Trade	$14,987		$10,633		$25,620		5.9%
Transportation and Warehousing	$6,539		$3,343		$9,882		2.3%
Information	$6,081		$9,836		$15,917		3.6%
Finance and Insurance	$17,197		$21,193		$38,389		8.8%
Real Estate and Rental & Leasing	$5,992		$22,764		$28,756		6.6%
Professional & Technical Services	$18,954		$5,948		$24,902		5.7%
Management of Companies and Enterprises	$8,915		$2,014		$10,928		2.5%
Administrative & Waste Services	$10,958		$2,506		$13,464		3.1%
Educational Services	$4,410		$585		$4,995		1.1%
Health Care and Social Assistance	$25,610		$3,018		$28,629		6.6%
Arts, Entertainment, and Recreation	$2,825		$1,394		$4,219		1.0%
Accommodation & Food Services	$6,846		$4,658		$11,504		2.6%
Other Services (except Public Administration)	$6,793		$971		$7,764		1.8%
Public Administration	$48,353		$14,073		$62,426		14.3%
Other Non-industries	$0		$30,834		$30,834		7.1%
Total	**$243,381**		**$193,010**		**$436,391**		**100.0%**

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

labor income comprise the state's total Gross State Product (GSP).

As shown in Table 1.5, the GSP of North Carolina is approximately $436.4 billion, equal to the sum of labor income ($243.4 billion) and non-labor income ($193 billion). In Section 2, we use GSP as the backdrop against which we measure the relative impacts of the universities on the state economy.

Table 1.6 provides the breakdown of jobs by industry in North Carolina. Among the state's non-government industry sectors, the Retail Trade sector is the largest employer, supporting 547,329 jobs or 10.2% of total employment in the state. The second largest employer is the Health Care and Social Assistance sector, supporting 537,510 jobs or 10.0% of the state's total employment. Altogether, the state supports 5.4 million jobs.[6]

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

TABLE 1.6: JOBS BY MAJOR INDUSTRY SECTOR IN NORTH CAROLINA, 2013*†

INDUSTRY SECTOR	TOTAL JOBS	% OF TOTAL
Agriculture, Forestry, Fishing, and Hunting	86,247	1.6%
Mining	7,356	0.1%
Utilities	12,970	0.2%
Construction	291,463	5.4%
Manufacturing	459,970	8.6%
Wholesale Trade	189,273	3.5%
Retail Trade	547,329	10.2%
Transportation and Warehousing	144,722	2.7%
Information	86,106	1.6%
Finance and Insurance	248,656	4.6%
Real Estate and Rental and Leasing	229,992	4.3%
Professional and Technical Services	306,383	5.7%
Management of Companies and Enterprises	83,229	1.6%
Administrative and Waste Services	367,979	6.9%
Educational Services	118,726	2.2%
Health Care and Social Assistance	537,510	10.0%
Arts, Entertainment, and Recreation	112,271	2.1%
Accommodation and Food Services	380,939	7.1%
Other Services (except Public Administration)	301,605	5.6%
Public Administration	852,696	15.9%
Total	**5,365,424**	**100.0%**

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

TABLE 1.7: EXPECTED INCOME IN NORTH CAROLINA AT THE MIDPOINT OF AN INDIVIDUAL'S WORKING CAREER BY EDUCATION LEVEL

EDUCATION LEVEL	INCOME	DIFFERENCE FROM NEXT LOWEST DEGREE	DIFFERENCE FROM HIGH SCHOOL DIPLOMA
Less than high school	$17,900	n/a	n/a
High school or equivalent	$28,500	$10,600	n/a
Associate's degree	$39,300	$10,800	$10,800
Bachelor's degree	$54,200	$14,900	$25,700
Master's degree	$70,300	$16,100	$41,800
Phd or professional	$88,800	$18,500	$60,300

Source: EMSI complete employment data.

FIGURE 1.1: EXPECTED INCOME BY EDUCATION LEVEL AT CAREER MIDPOINT

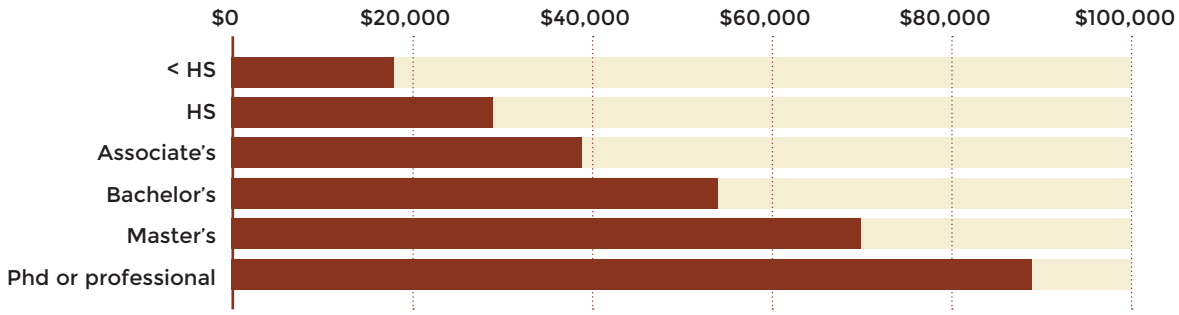


Table 1.7 presents the mean income by education level in North Carolina at the midpoint of the average-aged worker's career. These numbers are derived from EMSI's complete employment data on average income per worker in the state.[7] As shown, students have the potential to earn more as they achieve higher levels of education compared to maintaining a high school diploma. Students who achieve a bachelor's degree can expect $54,200 in income per year, approximately $25,700 more than someone with a high school diploma.

7 Wage rates in the EMSI SAM model combine state and federal sources to provide earnings that reflect complete employment in the state, including proprietors, self-employed workers, and others not typically included in state data, as well as benefits and all forms of employer contributions. As such, EMSI industry earnings-per-worker numbers are generally higher than those reported by other sources.

CHAPTER 2
ECONOMIC IMPACTS ON THE NORTH CAROLINA ECONOMY

The North Carolina economy is impacted by the UNC system in a variety of ways. The universities are employers and buyers of goods and services. They attract monies that would not have otherwise entered the state economy through their day-to-day operations, their research and extension activities, their construction projects, their clinical operations, and the expenditures of their out-of-state students and visitors. Further, they foster the development of new start-up companies and provide students with the knowledge, skills, and abilities they need to become productive citizens and contribute to the overall output of the state.

This section presents the total economic impact of the UNC system broken out according to the following categories:

1. Impact of **operations spending**
2. Impact of **spending on clinical services**
3. Impact of **spending on research and development**
4. Impact of **spending on construction**
5. Impact of **start-up companies** (with an additional assessment of spin-off companies)
6. Impact of **spending on extension services**
7. Impact of **student spending**

8. Impact of **visitor spending**
9. Impact of **alumni** employed in the North Carolina workforce.

Economic impact analyses use different types of measures when reporting estimated results. Frequently used is the sales impact, which comprises the change in business sales revenue in the economy as a result of increased economic activity. However, much of this sales revenue leaves the economy and overstates actual impacts. A more conservative measure – and the one employed in this study – is the **total added income impact**, which assesses the change in Gross State Product, or GSP. Total added income may be further broken out into the **labor income impact**, which assesses the change in employee compensation; and the **non-labor income impact**, which assesses the change in business profits and returns on capital. Another way to state the total added income impact is **job equivalents**, a measure of the number of full- and part-time jobs that would be required to support the change in total added income. All four of these measures – total added income, labor income, non-labor income, and job equivalents – are used to estimate the economic impact results presented in this section.

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

1. The **initial effect** is the exogenous shock to the economy caused by the initial spending of money, whether to pay for salaries and wages, purchase goods or services, or cover operating expenses.
2. 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 section in the context of the terms and definitions listed above. Note that, regardless of the effects used to decompose the results, the total impact measures are analogous.

EMSI	Initial	Direct	Indirect	Induced
IMPLAN	Direct	Indirect		Induced

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

2.1 OPERATIONS SPENDING IMPACT

Faculty and staff payroll is part of the state's overall income, and the spending of employees for groceries, apparel, and other household spending helps support state businesses. The universities themselves purchase supplies and services, and many of their vendors are located in North Carolina. These expenses create a ripple effect that generates still more jobs and income throughout the economy.

Table 2.1 presents the expenses of the universities in FY 2012-13 by type of cost, less expenses for research, extension, and clinical activities (the impacts of these expenses are described and assessed separately in the following subsections). Three main categories appear in the table: 1) salaries, wages, and benefits, 2) capital depreciation, and 3) all other expenses, including purchases for supplies and services. Further detail on where expenses occur – whether in-state or out-of-state – is also provided.

The first step in estimating the impact of the expenses shown in Table 2.1 is to map them to the approximately 1,100 industries of the EMSI SAM model. Assuming that the spending patterns of the universities' personnel approximately match those of the average consumer, we map salaries, wages, and benefits to spending on industry outputs using national household expenditure coefficients supplied by EMSI's national SAM. Approximately 97% of the people working at UNC universities live in North Carolina (see Table 1.1), and therefore we consider only 97% of the salaries, wages, and benefits. For the other two expense categories (i.e., capital depreciation and all other expenses), we assume the universities' spending patterns approximately match national averages and apply the national spending

TABLE 2.1: EXPENSES BY TYPE OF COST OF UNC UNIVERSITIES (LESS RESEARCH, EXTENSION, AND CLINICAL ACTIVITIES), FY 2012-13

TYPE OF COST	TOTAL EXPENSES (THOUSANDS)	IN-STATE EXPENSES (THOUSANDS)	OUT-OF-STATE EXPENSES (THOUSANDS)
Salaries, wages, and benefits	$3,482,103	$1,585,406	$1,896,697
Capital depreciation	$480,637	$343,768	$136,869
All other expenses	$1,668,745	$937,033	$731,712
Total	**$5,631,485**	**$2,866,207**	**$2,765,278**

Source: Data supplied by UNC universities and the EMSI impact model.

TABLE 2.2: IMPACT OF THE OPERATIONS SPENDING OF UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$3,482,103**		**$0**		**$3,482,103**		**51,542**
MULTIPLIER EFFECT							
Direct effect	$411,572		$456,598		$868,170		10,802
Indirect effect	$103,886		$86,927		$190,813		2,658
Induced effect	$1,255,613		$1,276,056		$2,531,669		34,589
Total multiplier effect	**$1,771,071**		**$1,819,581**		**$3,590,652**		**48,049**
GROSS IMPACT (INITIAL + MULTIPLIER)	**$5,253,174**		**$1,819,581**		**$7,072,755**		**99,591**
Less alternative uses of funds	-$1,601,339		-$1,576,571		-$3,177,909		-44,759
NET IMPACT	**$3,651,835**		**$243,011**		**$3,894,846**		**54,832**

Source: EMSI impact model.

coefficients for NAICS 611310 (Colleges, Universities, and Professional Schools). Capital depreciation is mapped to the construction sectors of NAICS 611310 and the universities' remaining expenses to the non-construction sectors of NAICS 611310.

We now have three expense vectors for UNC universities: one for salaries, wages, and benefits; another for capital depreciation; and a third for the universities' purchases of supplies and services. The next step is to estimate the portion of these expenses that occurs inside the state. Those that occur outside the state are known as leakages. We estimate in-state expenses using regional purchase coefficients (RPCs), a measure of the overall demand for the commodities produced by each industry sector that is satisfied by state suppliers, for each of the approximately 1,100 industries in the SAM model.[8] For example, if 40% of the demand for NAICS 541211 (Offices of Certified Public Accountants) is satisfied by state suppliers, the RPC for that industry is 40%. The remaining 60% of the demand for NAICS 541211 is provided by suppliers located outside the state. The three vectors of expenses are multiplied, industry by industry, by the corresponding RPC to arrive at the in-state expenses associated with the universities. Finally, in-state spending is entered, industry by industry, into the SAM model's multiplier matrix, which in turn provides an estimate of the associated multiplier effects on state labor income, non-labor income, total added income, and job equivalents.

Table 2.2 presents the economic impact of the universities' operations. The people employed by UNC universities and their salaries, wages, and benefits comprise the initial effect, shown in the top row in terms of labor income, non-labor income, total added income, and job equivalents. The additional impacts

8 See Appendix 3 for a description of EMSI's SAM model.

created by the initial effect appear in the next four rows under the heading "Multiplier effect." Summing initial and multiplier effects, the gross impacts are $5.3 billion in labor income and $1.8 billion in non-labor income. This comes to a total impact of $7.1 billion in total added income, equivalent to 99,591 jobs, associated with the spending of the universities and their employees in the state.

The $7.1 billion in total gross total added income is often reported by other researchers as an impact. We go a step further to arrive at a net impact by applying a counterfactual scenario, i.e., what has not happened but what would have happened if a given event – in this case, the expenditure of in-state funds on UNC universities – had not occurred. The universities received an estimated 73.5% of their funding from sources within North Carolina. These monies came from the tuition and fees paid by resident students, from the auxiliary revenue and donations from private sources located within the state, from state and local taxes, and from the financial aid issued to students by state and local government. We must account for the opportunity cost of this in-state funding. Had other industries received these monies rather than UNC universities, income impacts would have still been created in the economy. In economic analysis, impacts that occur under counterfactual conditions are used to offset the impacts that actually occur in order to derive the true impact of the event under analysis.

We estimate this counterfactual by simulating a scenario where in-state monies spent on the universities are instead spent on consumer goods and savings. This simulates the in-state monies being returned to the taxpayers and being spent by the household sector. Our approach is to establish the total amount spent by in-state students and taxpayers on UNC universities, map this to the detailed industries of the SAM model using national household expenditure coefficients, use the industry RPCs to estimate in-state spending, and run the in-state spending through the SAM model's multiplier matrix to derive multiplier effects. The results of this exercise are shown as negative values in the row labeled "Less alternative uses of funds" in Table 2.2.

The total net impacts of the universities' operations are equal to the total gross impacts less the impact of the alternative use of funds – the opportunity cost of the state and local money. As shown in the last row of Table 2.2, the total net impact is approximately $3.7 billion in labor income and $243 million in non-labor income. This totals $3.9 billion in total added income and is equivalent to 54,832 jobs. These impacts represent new economic activity created in the state economy solely attributable to the operations of UNC universities.

2.2 CLINICAL SPENDING IMPACT

In this section we estimate the economic impact of the spending of the clinics and hospitals related to the UNC system. These include the following:

1. East Carolina University Division of Health Sciences
2. North Carolina Memorial Hospital
3. North Carolina Children's Hospital
4. North Carolina Women's Hospital
5. North Carolina Cancer Hospital
6. North Carolina Neurosciences Hospital
7. Pardee Hospital

All but East Carolina University Division of Health Sciences are collectively referred to

TABLE 2.3: CLINICAL EXPENSES BY FUNCTION, FY 2012-13

TYPE OF COST	TOTAL EXPENSES (THOUSANDS)	IN-STATE EXPENSES (THOUSANDS)	OUT-OF-STATE EXPENSES (THOUSANDS)
Salaries, wages and benefits	$1,104,412	$517,166	$587,246
Capital depreciation	$79,345	$58,122	$21,223
All other expenses	$528,040	$365,641	$162,398
Total	**$1,711,796**	**$940,930**	**$770,867**

Source: Data supplied by UNC universities.

TABLE 2.4: IMPACT OF THE OPERATIONS SPENDING OF UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$1,097,840**		**$0**		**$1,097,840**		**11,350**
MULTIPLIER EFFECT							
Direct effect	$149,021		$141,801		$290,821		3,823
Indirect effect	$38,077		$31,027		$69,104		927
Induced effect	$426,903		$412,950		$839,853		11,659
Total multiplier effect	**$614,001**		**$585,778**		**$1,199,779**		**16,409**
GROSS IMPACT (INITIAL + MULTIPLIER)	**$1,711,841**		**$585,778**		**$2,297,619**		**27,759**
Less alternative uses of funds	-$1,601,339		-$1,576,571		-$3,177,909		-44,759
NET IMPACT	**$3,651,835**		**$243,011**		**$3,894,846**		**54,832**

Source: EMSI impact model.

elsewhere in the report as the UNC Medical Center. Note that the broader health-related impacts of healthcare provided through these clinics and hospitals are beyond the scope of this analysis and are not included.

In FY 2012-13, over $1.7 billion was spent on clinical operations for the UNC clinics and hospitals. To avoid any double counting, this spending was not included in the operations spending impact previously reported. Any medical research expenses from these medical institutions were accounted for in the research spending impact and are not included here.

The methodology used here is similar to that used when estimating the impact of operations spending. Salaries, wages, and benefits are mapped to industries using national household expenditure coefficients. Assuming the clinics and hospitals affiliated with the UNC system have a spending pattern similar to that

of average general and surgical hospitals in North Carolina, we map their capital and other expenses to the industries of the SAM model using general and surgical hospital spending coefficients. Next, we remove the spending that occurs outside the state, and run the in-state expenses through the multiplier matrix. Unlike the previous section, we do not estimate the impacts that would have been created with an alternative use of these funds. This is because there is not a significant alternative to spending money on health care. Table 2.4 on the previous page presents the impacts of the UNC clinics and hospitals.

The payroll and number of people employed by the UNC clinics and hospitals comprise the initial effect. The total impacts of clinical expenses (the sum of the initial and multiplier effects) are $1.7 billion in added labor income and $585.8 million in non-labor income, totaling in $2.3 billion total added income – or the equivalent of 27,759 jobs.

2.3 RESEARCH SPENDING IMPACT

Similar to the day-to-day operations of UNC universities, research activities impact the economy by employing people and requiring the purchase of equipment and other supplies and services. Table 2.5 shows UNC universities' research expenses by function – payroll, equipment, construction, and other – for the last four fiscal years. In FY 2012-13, UNC universities spent over $1.6 billion on research and development activities. These expenses would not have been possible without funding from outside the state – UNC universities received around 59% of their research funding from federal and other sources.

We employ a methodology similar to the one used to estimate the impacts of operational expenses. We begin by mapping total research expenses to the industries of the SAM model, removing the spending that occurs outside the state, and then running the in-state expenses through the multiplier matrix. As with the operations spending impact, we also adjust the gross impacts to account for the opportunity cost of monies withdrawn from the state and local economy to support the research of UNC universities, whether through state-sponsored research awards or through private donations. Again, we refer to this adjustment as the alternative use of funds.

Mapping the research expenses by category to the industries of the SAM model – the only difference from our previous methodology – requires some exposition. The National Science Foundation's Higher Education Research

TABLE 2.5: RESEARCH EXPENSES BY FUNCTION OF UNC UNIVERSITIES, FY 2012-13

FISCAL YEAR	PAYROLL (THOUSANDS)	EQUIPMENT (THOUSANDS)	CONSTRUCTION (THOUSANDS)	OTHER (THOUSANDS)	TOTAL (THOUSANDS)
2012-13	$717,156	$31,658	$168,389	$646,279	$1,563,481
2011-12	$673,043	$33,310	$152,985	$610,782	$1,470,121
2010-11	$647,473	$34,951	$139,069	$606,903	$1,428,395
2009-10	$548,761	$31,587	$136,641	$568,191	$1,285,181

Source: Data supplied by UNC universities.

TABLE 2.6: IMPACT OF THE RESEARCH ACTIVITIES OF UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$717,156**		**$0**		**$717,156**		**10,600**
MULTIPLIER EFFECT							
Direct effect	$193,550		$169,488		$363,038		5,021
Indirect effect	$47,447		$40,120		$87,566		1,189
Induced effect	$345,930		$313,996		$659,926		9,280
Total multiplier effect	**$586,927**		**$523,604**		**$1,110,531**		**15,490**
GROSS IMPACT (INITIAL + MULTIPLIER)	**$1,304,083**		**$523,604**		**$1,827,687**		**26,090**
Less alternative uses of funds	-$142,973		-$140,761		-$283,734		-3,996
NET IMPACT	**$1,161,110**		**$382,842**		**$1,543,953**		**22,094**

Source: EMSI impact model.

and Development Survey (HERD) is completed annually by universities that spend in excess of $150,000 on research and development. Table 67 in the 2012 HERD lists each university's research expenses by field of study.[9] We map these fields of study to their respective industries in the SAM model. This implicitly assumes researchers at UNC universities will have similar spending patterns to private sector researchers in similar fields. The result is a distribution of research expenses to the various 1,100 industries that follows a weighted average of the fields of study reported in the HERD survey. This assumption serves as our best estimate of the distribution of research expenses across the various industries without individually surveying researchers at UNC universities.

Initial, direct, indirect, and induced effects of UNC universities' research expenses appear in Table 2.6. As with the operations spending impact, the initial effect consists of the 10,600 jobs and their associated salaries, wages, and benefits. The institutions' research expenses have a total gross impact of $1.3 billion in labor income and $523.6 million in non-labor income. This totals $1.8 billion in total added income, equivalent to 26,090 jobs. Taking into account the impact of the alternative uses of funds, net research expenditure impacts of UNC universities are $1.2 billion in labor income and $382.8 million in non-labor income, totaling $1.5 billion in total added income and equivalent to 22,094 jobs.

Research and innovation plays an important role in driving the North Carolina economy. Some indicators of innovation are the number of invention disclosures, patent applications, and licenses and options executed. Over the last four years, UNC universities received 1,695 invention disclosures, filed 855 new US patent applications, and produced 625 licenses (see

9 The fields include environmental sciences, life sciences, math and computer sciences, physical sciences, psychology, social sciences, sciences not elsewhere classified, engineering, and all non-science and engineering fields.

TABLE 2.7: INVENTION DISCLOSURES, PATENT APPLICATIONS, LICENSES, AND LICENSE INCOME OF UNC UNIVERSITIES

FISCAL YEAR	INVENTION DISCLOSURES RECEIVED	PATENT APPLICATIONS FILED	LICENSES AND OPTIONS EXECUTED	ADJUSTED GROSS LICENSE INCOME
2012-13	448	232	197	$10,752,322
2011-12	521	232	145	$8,332,194
2010-11	410	225	147	$6,439,012
2009-10	316	166	136	$8,364,977
Total	**1,695**	**855**	**625**	**$33,888,505**

Source: Data supplied by UNC universities.

Table 2.7). Total license income over the same four-year time period grew from $8.4 million in FY 2009-10 to $10.8 million in FY 2012-13, an approximate $2.4 million increase. Without the research activities of UNC universities, this level of innovation and sustained economic growth would not have been possible.

2.4 CONSTRUCTION SPENDING IMPACT

In this section we estimate the economic impact of the construction spending of UNC universities. Because construction funding is separate from operations funding in the budgeting process, it is not captured in the operations spending impact estimated in the previous section. However, like the operations spending, the construction spending creates subsequent rounds of spending and multiplier effects that generate still more jobs and income throughout the state. During FY 2012-13, UNC universities spent a total of $648.6 million on various construction projects.

The methodology used here is similar to that used when estimating the impact of operations capital spending. Assuming UNC universities' construction spending approximately matches the average construction spending pattern of colleges and universities in North Carolina, we map UNC universities' construction spending to the construction industries of the EMSI SAM model. Next, we use the RPCs to estimate the portion of this spending that occur in-state. Finally, the in-state spending is run through the multiplier matrix to estimate the direct, indirect and induced effects. Because construction is so labor intensive, the non-labor income impact is relatively small.

To account for the opportunity cost of any in-state construction money, we estimate the impacts of a similar alternative uses of funds as found in the operations and research spending impacts. This is done by simulating a scenario where in-state monies spent on construction are instead spent on consumer goods. These impacts are then subtracted from the gross construction spending impacts. Because construction is so labor intensive, most of the added income is labor income as opposed to non-labor income. As a result, the non-labor impacts associated with spending in the non-construction sectors are larger than in the construction sectors, so the net non-labor impact of construction spending is negative.

TABLE 2.8: IMPACT OF CONSTRUCTION SPENDING OF UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$0**		**$0**		**$0**		**0**
MULTIPLIER EFFECT							
Direct effect	$219,231		$19,851		$239,082		5,453
Indirect effect	$59,370		$5,376		$64,746		1,469
Induced effect	$133,715		$12,107		$145,822		3,321
GROSS IMPACT	**$412,317**		**$37,334**		**$449,651**		**10,243**
Less alternative uses of funds	-$139,312		-$137,157		-$276,470		-3,894
NET IMPACT	**$273,005**		**-$99,824**		**$173,181**		**6,349**

Source: EMSI impact model.

This means that had the construction money been spent on consumer goods, more non-labor income would have been created at the expense of less labor income. The total net impact is still positive and substantial.

Table 2.8 presents the impacts of the UNC universities' construction spending during FY 2012-13. Note the initial effect is purely a sales effect, so there is no initial change in labor or non-labor income. The FY 2012-13 construction spending of UNC universities creates a net total short-run impact of $173.2 million in total added income – the equivalent of creating 6,349 new jobs – for the state of North Carolina.

2.5 IMPACT OF START-UP AND SPIN-OFF COMPANIES

This subsection presents the economic impact of companies that would not have existed in the state but for the presence of UNC universities. To estimate these impacts, we categorize companies according to the following types:

- **Start-up companies:** Companies created specifically to license and commercialize technology or knowledge of UNC universities.
- **Spin-off companies:** Companies created and fostered through programs offered by UNC universities that support entrepreneurial business development, or companies that were created by faculty, students, or alumni as a result of their experience at UNC universities.

We vary our methodology from the previous sections in order to estimate the impacts of start-up and spin-off companies. Ideally, we would use detailed financial information for all start-up and spin-off companies to estimate their impacts. However, collecting that information is not feasible and would raise a number of privacy concerns. As an alternative, we use the number of employees of each start-up and spin-off companies that were collected and reported by the universities. Table 2.9 presents the number of employees for all start-up and spin-off companies related to UNC universities that were active in North Carolina during the analysis year.

First, we match each start-up and spin-off

companies with the closest NAICS industry. Next, we assume the companies have earnings and spending patterns – or production functions – similar to their respective industry averages. Given the number of employees reported for each company, we use industry-specific jobs-to-earnings and earnings-to-sales ratios to estimate the sales of each business. Once we have the sales estimates, we follow a similar methodology as outlined in the previous sections by running sales through the SAM to generate the direct, indirect, and induced multiplier effects.

Table 2.10 presents the impacts of the start-up companies. The initial effect is the 4,179 jobs, equal to the number of employees at all start-up companies in the state (from Table 2.9). The corresponding initial effect on labor income is $383.2 million. The amount of income per job created by the start-up companies is much higher than in the previous sections. This is due to the higher average incomes within the industries of the start-up companies. The total impacts (the sum of the initial, direct, indirect, and induced effects) are $706.5 million in added labor income and $713.7 million in non-labor income, totaling $1.4 billion in total added income – or the equivalent of 7,712 jobs.

Note that start-up companies have a strong and clearly defined link to UNC universities. The link between the universities and the existence of their spin-off companies, however, is less direct and is thus viewed as more subjective. For this reason, their impacts are estimated separately from the start-up com-

TABLE 2.9: START-UP AND SPIN-OFF COMPANIES RELATED TO UNC UNIVERSITIES THAT WERE ACTIVE IN NORTH CAROLINA IN FY 2012-13

	NUMBER OF COMPANIES	NUMBER OF EMPLOYEES
Start-up companies	146	4,199
Spin-off companies	254	13,240

Source: Data supplied by UNC universities.

TABLE 2.10: IMPACT OF START-UP COMPANIES RELATED TO UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$383,184**		**$400,902**		**$784,086**		**4,179**
MULTIPLIER EFFECT							
Direct effect	$55,197		$42,845		$98,042		579
Indirect effect	$14,999		$11,813		$26,812		157
Induced effect	$253,163		$258,118		$511,280		2,798
Total multiplier effect	**$323,358**		**$312,776**		**$636,134**		**3,533**
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$706,543**		**$713,678**		**$1,420,221**		**7,712**

Source: EMSI impact model.

TABLE 2.11: IMPACT OF SPIN-OFF COMPANIES RELATED TO UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$725,541**		**$310,366**		**$1,035,907**		**13,240**
MULTIPLIER EFFECT							
Direct effect	$173,162		$61,418		$234,581		2,793
Indirect effect	$46,428		$16,542		$62,969		747
Induced effect	$537,133		$228,703		$765,837		10,078
Total multiplier effect	**$756,723**		**$306,663**		**$1,063,387**		**13,619**
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$1,482,264**		**$617,030**		**$2,099,294**		**26,858**

Source: EMSI impact model.

panies and are excluded from the grand total impact presented later in this report.[10]

As demonstrated in Table 2.11, the universities create an exceptional environment that fosters innovation and entrepreneurship. As a result, the impacts of spin-off companies related to UNC universities are $1.5 billion in added labor income and $617 million in non-labor income, totaling $2.1 billion in total added income – the equivalent of 26,858 jobs.

2.6 EXTENSION SPENDING IMPACT

The North Carolina Cooperative Extension Service is a partnership between North Carolina State University and North Carolina A&T State University. Its purpose is to provide education and technology to help address the needs and local problems of North Carolina's diverse communities and serves all of North Carolina's 100 counties. North Carolina State University also operates an Industrial Extension Service program that caters to North Carolina's industries and businesses.

In FY 2012-13, over $78.3 million were spent on extension services. This spending includes money from multiple sources – funding from the universities themselves and funding from the counties where extension services are offered. In this section we estimate the economic impacts of extension spending on the state of North Carolina. The broader impacts of extensions services – e.g., the impact of nutritional education programs – are beyond the scope of this analysis and are not included. Similar to the research and clinical spending, we exclude the universities' extension spending from the operations spending impact to avoid double counting.

The methodology used here mirrors that used in the estimation of the operations impact. As shown in Table 2.12, the bulk of extension service spending is in salaries, wages,

10 The readers are ultimately responsible for making their own judgment on the veracity of the linkages between spin-off companies and UNC universities. At the very least, the impacts of the spin-off businesses provide important context for the broader effects of UNC universities.

TABLE 2.12: EXTENSION SERVICES SPENDING BY FUNCTION OF UNC UNIVERSITIES, FY 2012-13

EXPENSE CATEGORY	TOTAL EXPENSES (THOUSANDS)	IN-STATE EXPENSES (THOUSANDS)	OUT-OF-STATE EXPENSES (THOUSANDS)
Salaries, wages, and benefits	$63,640	$29,979	$33,661
Other	$14,704	$8,257	$6,448
Total	**$78,344**	**$38,236**	**$40,108**

Source: Data supplied by North Carolina State University and North Carolina A&T State University.

TABLE 2.13: IMPACT OF THE EXTENSION SERVICES OF UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$63,640**		**$0**		**$63,640**		**825**
MULTIPLIER EFFECT							
Direct effect	$2,195		$3,894		$6,089		60
Indirect effect	$528		$731		$1,259		14
Induced effect	$20,128		$20,948		$41,076		561
Total multiplier effect	**$22,851**		**$25,573**		**$48,423**		**634**
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$86,490**		**$25,573**		**$112,063**		**1,459**

Source: EMSI impact model.

and benefits. As in the previous sections, this spending is mapped to industries using national household expenditure coefficients. For the remaining spending, we assume extension services' spending patterns approximately match spending patterns of the host university, and we map the remaining spending to the various industries using the average spending coefficients for colleges and universities in North Carolina.

Extension staff and their labor income constitute the initial effect. The total impacts of extension expenses of UNC universities (the sum of the initial, direct, indirect, and induced effects) are $86.5 million in added labor income and $25.6 million in non-labor income, totaling in $112.1 million total added income – equivalent to 1,459 jobs.

Appendix 4 presents the economic impacts of extension spending for North Carolina's eight Prosperity Zones. Because these are not statewide impacts, the Prosperity Zone impacts should not be added to any other impacts presented in this analysis.

2.7 STUDENT SPENDING IMPACT

An estimated 25,597 students came from outside the state and lived off campus while attending the universities in FY 2012-13. These students spent money at state businesses for

TABLE 2.14: AVERAGE STUDENT COSTS AND TOTAL SALES GENERATED BY OUT-OF-STATE STUDENTS IN NORTH CAROLINA, FY 2012-13

Room and board	$8,469
Personal expenses	$2,241
Transportation	$1,366
Total expenses per student	**$12,076**
Number of students who lived in the state off-campus	25,597
Number of students who lived in the state on-campus	12,178
Gross sales	**$378,830,340**
Wages and salaries paid to student workers*	$36,842,915
Net off-campus sales	**$341,987,425**

** This figure reflects only the portion of payroll that was used to cover the living expenses of non-resident student workers who lived in the state.*

Source: Student costs supplied by UNC universities. The number of students who lived in the state and off-campus or on-campus while attending is derived from the student origin data and in-term residence data supplied by UNC universities. The data is based on all students.

groceries, accommodation, transportation, and so on. Another estimated 12,178 out-of-state students lived on campus while attending UNC universities. These students also spent money while attending, although we exclude most of their spending for room and board since these expenditures are already reflected in the impact of the universities' operations. Collectively, the off-campus expenditures of out-of-state students supported jobs and created new income in the state economy.[11]

The average off-campus costs of out-of-state students appear in the first section of Table 2.14, equal to $12,076 per student. Note that this figure excludes expenses for books and supplies, since many of these monies are already reflected in the operations impact discussed in the previous section. We multiply the $12,076 in annual costs by the number of students who lived in the state but off-campus while attending (25,597 students) to estimate their total spending. For students living on campus, we multiply the per-student cost of personal expenses, transportation, and off-campus food purchases (assumed to be equal to 25% of room and board) by the number of students who lived in the state but on-campus while attending (12,178 students). Altogether, off-campus student spending generated gross sales of $378.8 million. This figure, once net of the monies paid to student workers, yields net off-campus sales of $342 million, as shown in the bottom row of the Table 2.14.

Estimating the impacts generated by the $342 million in student spending follows a procedure similar to that of the operations impact described above. We distribute the $342 million in sales to the industry sectors of the SAM model, apply RPCs to reflect in-state spending only, and run the net sales figures through the SAM model to derive multiplier effects.

11 Online students and students who commuted to North Carolina from outside the state are not considered in this calculation because their living expenses predominantly occurred in the state where they resided during the analysis year.

TABLE 2.15: IMPACT OF THE SPENDING OF OUT-OF-STATE STUDENTS ATTENDING UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$0**		**$0**		**$0**		**0**
MULTIPLIER EFFECT							
Direct effect	$71,369		$84,557		$155,926		2,904
Indirect effect	$16,584		$17,636		$34,220		662
Induced effect	$47,123		$56,325		$103,448		1,810
Total multiplier effect	**$135,076**		**$158,518**		**$293,595**		**5,377**
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$135,076**		**$158,518**		**$293,595**		**5,377**

Source: EMSI impact model.

Table 2.15 presents the results. Unlike the previous subsections, the initial effect is purely sales-oriented and there is no change in labor or non-labor income. The impact of out-of-state student spending thus falls entirely under the multiplier effect. The total impact of out-of-state student spending is $135.1 million in labor income and $158.5 million in non-labor income, totaling $293.6 million in total added income, or 5,377 jobs. These values represent the direct effects created at the businesses patronized by the students, the indirect effects created by the supply chain of those businesses, and the effects of the increased spending of the household sector throughout the state economy as a result of the direct and indirect effects.

It is important to note that students from the state also spend money while attending UNC universities. However, had they lived in the state without attending UNC universities, they would have spent a similar amount of money on their living expenses. We make no inference regarding the number of students that would have left the state had they not attended UNC universities. Had the impact of these students been included, the results presented in Table 2.15 would have been much greater.

2.8 VISITOR SPENDING IMPACT

In addition to out-of-state students, thousands of visitors came to UNC universities to participate in various activities, including commencement, sports events, and orientation. While some UNC universities were able to provide the number of out-of-state visitors based on total visitors reported in their Community Engagement Survey, others were not. For those unable to provide out-of-state visitor information, we applied estimates based on the available data. We also added to the number of out-of-state visitors the conservative assumption that each out-of-state student living on- or off-campus in North Carolina received two visitors throughout FY 2012-13. Combining the information provided by the universities with our estimates, approximately 1 million out-of-state visitors attended events hosted by UNC universities in FY 2012-13.

Table 2.16 presents the average expenditures per person-trip for accommodation, food, transportation, and other personal expenses (including shopping and entertainment). These figures were reported in a 2013 study conducted for the North Carolina Department of Commerce. Based on these figures, the gross spending of out-of-state visitors totaled $400.8 million in FY 2012-13. However, some of this spending includes monies paid to the universities through non-textbook items (e.g., event tickets, food, etc.). These have already been accounted for in the operations and should thus be removed to avoid double-counting. We estimate that on-campus sales generated by out-of-state visitors totaled $70.8 million. The net sales from out-of-state visitors in FY 2012-13 thus come to $330 million.

Calculating the increase in state income as a result of visitor spending again requires use of the SAM model. The analysis begins by discounting the off-campus sales generated

TABLE 2.16: AVERAGE VISITOR COSTS AND SALES GENERATED BY OUT-OF-STATE VISITORS IN NORTH CAROLINA, FY 2012-13

Accommodation	$67
Food	$126
Entertainment and shopping	$74
Transportation	$116
Total expenses per visitor	**$383**
Number of out-of-state visitors	1,046,761
Gross sales	**$400,760,102**
On-campus sales (excluding textbooks)	$70,781,013
Net off-campus sales	**$329,979,089**

Source: Impact of Visitor Spending, prepared for the North Carolina Department of Commerce, 2014. Sales calculations by EMSI estimated based on data provided by UNC universities.

TABLE 2.17: IMPACT OF THE SPENDING OF OUT-OF-STATE VISITORS OF UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$0**		**$0**		**$0**		**0**
MULTIPLIER EFFECT							
Direct effect	$81,725		$50,071		$131,797		3,357
Indirect effect	$16,534		$11,871		$28,404		752
Induced effect	$58,703		$34,471		$93,174		2,365
Total multiplier effect	**$156,962**		**$96,413**		**$253,375**		**6,474**
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$156,962**		**$96,413**		**$253,375**		**6,474**

Source: EMSI impact model.

by out-of-state visitors to account for leakage in the trade sector, and then bridging the net figures to the detailed sectors of the SAM model. The model runs the net sales figures through the multiplier matrix to arrive at the multiplier effects. As shown in Table 2.17 on the previous page, the net impact of visitor spending in FY 2012-13 comes to $157 million in labor income and $96.4 million in non-labor income. This totals $253.4 million in total added income and is equivalent to 6,474 jobs.

2.9 ALUMNI IMPACT

While UNC universities create an economic impact through their spending and the spending of their students and visitors, the greatest economic impact of UNC universities stems from the added human capital – the knowledge, creativity, imagination, and entrepreneurship – found in their alumni. While attending UNC universities, students receive experience, education, and the knowledge, skills, and abilities that increase their productivity and allow them to command a higher wage once they enter the workforce. But with roughly 84% of UNC alumni remaining in the state upon exiting the universities, 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 UNC universities' alumni enjoy the fruits of this increased productivity in the form of additional non-labor income (i.e., higher profits).

In this section we estimate the economic impacts stemming from the higher labor income of alumni in combination with their employers' higher non-labor income. Former students who achieved a degree as well as those who may not have finished a degree or who did not take courses for credit are considered alumni. The methodology here differs from the previous impacts in one fundamental way. Whereas the other impacts depend on an annually renewed injection of new sales in the state economy, the alumni impact is the result of years of past instruction and the associated accumulation of human capital. This is an important distinction that sets the alumni impact apart from the other impacts presented in this report.

The initial effect of alumni comprises two main components. The first and largest of these is the added labor income of the universities' alumni, and the second comprises the added non-labor income of the businesses where the alumni are employed. To derive the initial effect, we estimate the portion of alumni that are employed in the workforce using 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;[12] 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 U.S. Census Bureau. Applying these factors to the universities' historical student 12-month enrollments yields the estimated number of alumni that were still actively employed in the state as of FY 2012-13.

The next step is to quantify the skills that alumni acquired from the universities, using the students' production of credit hour equivalents (CHEs) as a proxy for skills. To do this, we multiply the number of alumni still employed

12 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.

TABLE 2.18: NUMBER OF CHEs IN WORKFORCE AND INITIAL LABOR INCOME CREATED IN NORTH CAROLINA, FY 2012-13

Number of CHEs in workforce	101,600,102
Average value per CHE	$162
Initial labor income, gross	**$16,468,745,860**
COUNTERFACTUALS	
Percent reduction for alternative education opportunities	15%
Percent reduction for adjustment for labor import effects	50%
Initial labor income, net	**$6,999,216,991**

Source: EMSI impact model.

in the workforce by the 7.4 average CHEs per student (see Table 1.4)[13] to generate an estimate of approximately 101.6 million CHEs active in the workforce. Note that alumni who enrolled at the universities more than one year are counted at least twice – if not more – in the calculations. However, CHEs remain distinct regardless of when and by whom they were earned, so there is no duplication in the CHE counts.

Next, we estimate the value of the CHEs. This is done using the incremental added labor income stemming from the students' higher wages. The incremental labor income is the difference between the wages earned by alumni and the alternative wage they would have earned had they not attended college. Using the CHEs earned by students and the associated wage differentials between education levels, we estimate the average value per CHE to be equal to $162. This value represents the average incremental increase in wages that alumni of UNC universities received during the analysis year for every CHE they completed. For a more detailed discussion of the calculation of this variable, see Appendix 5.

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 2012-13, and the lowest value per CHE applied to students who were just entering the workforce. 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 $16.5 billion in gross labor income in increased wages received by former students in FY 2012-13 (as shown in Table 2.18).

The next two rows in Table 2.18 show two adjustments used to account for counterfactual outcomes. As discussed above, counterfactual outcomes in economic impact analysis represent what would have happened if a given event had not occurred. The event in question is the education and training provided by UNC universities and subsequent influx of

13 This assumes the average CHE production and level of study from past years is equal to the CHE production and level of study of students during the analysis year.

skilled labor into the state economy. The first counterfactual scenario that we address is the adjustment for alternative education opportunities. In the counterfactual scenario where UNC universities did not exist, we assume a portion of UNC universities' alumni would have received a comparable education elsewhere in the state or would have left the state and received a comparable education and then returned to the state. The incremental labor income that accrues to those students cannot be counted towards the added labor income from alumni of UNC universities. The adjustment for alternative education opportunities amounts to an estimated 15% reduction of the $16.5 billion in added labor income.[14] This represents an estimation of the added labor income from alumni of UNC universities that would have been generated in the state anyway, even if the universities did not exist. For more information on the alternative education adjustment, see Appendix 6.

The other adjustment in Table 2.18 accounts for the importation of labor. Suppose UNC universities did not exist and in consequence there were fewer skilled workers in the state. Businesses could still satisfy some of their need for skilled labor by recruiting from outside North Carolina. 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 state businesses could have been filled by workers recruited from outside the state if the universities did not exist.[15] We conduct a sensitivity analysis for this assumption in Section 4. With the 50% adjustment, the net labor income added to the economy comes to $7 billion, as shown in Table 2.18.

14 For a sensitivity analysis of the alternative education opportunities variable, see Section 4.

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

The $7 billion in added labor income appears under the initial effect in the labor income column of Table 2.19. To this we add an estimate for initial non-labor income. As discussed earlier in this section, businesses that employ former students of UNC universities 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 ($7 billion) to the six-digit NAICS industry sectors where students are most likely to be employed. This allocation entails a process that maps completers in the state to the detailed occupations for which those completers have been trained, and then maps the detailed occupations to the six-digit industry sectors in the SAM model.[16] Using a crosswalk created by National Center for Education Statistics (NCES) and the Bureau of Labor Statistics (BLS), we map the breakdown of the state's completers to the approximately 700 detailed occupations in the Standard Occupational Classification (SOC) system. Finally, we apply a matrix of wages by industry and by occupation from the SAM model to map the occupational distribution of the $7 billion in initial labor income effects to the detailed industry sectors in the SAM model.[17]

Once these allocations are complete, we apply the ratio of non-labor to labor income provided by the SAM model for each sector to our estimate of initial labor income. This computation yields an estimated $2.1 billion in non-labor income that can be attributable

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

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

TABLE 2.19: IMPACT OF ALUMNI OF UNC UNIVERSITIES, FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$6,999,217**		**$2,126,403**		**$9,125,620**		**148,336**
MULTIPLIER EFFECT							
Direct effect	$1,079,715		$389,013		$1,468,728		23,448
Indirect effect	$290,627		$110,982		$401,608		6,379
Induced effect	$5,458,558		$1,421,952		$6,880,510		115,833
Total multiplier effect	**$6,828,900**		**$1,921,947**		**$8,750,847**		**145,659**
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$13,828,117**		**$4,048,350**		**$17,876,467**		**293,995**

Source: EMSI impact model.

to the universities' alumni. Summing initial labor and non-labor income together provides the total initial effect of alumni on the North Carolina economy, equal to approximately $9.1 billion. To estimate multiplier effects, we convert the industry-specific income figures generated through the initial effect to sales using sales-to-income ratios from the SAM model. We then run the values through the SAM's multiplier matrix.

Table 2.19 shows the multiplier effects of alumni. Multiplier effects occur as alumni generate an increased demand for consumer goods and services through the expenditure of their higher wages. Further, as the industries where alumni are employed increase their output, there is a corresponding increase in the demand for input from the industries in the employers' supply chain. Together, the incomes generated by the expansions in business input purchases and household spending constitute the multiplier effect of the increased productivity of the universities' alumni. The final results are $6.8 billion in labor income and $1.9 billion in non-labor income, for an overall total of $8.8 billion in multiplier effects. The grand total impact of alumni thus comes to $17.9 billion in total added income, the sum of all initial and multiplier labor and non-labor income impacts. This is equivalent to 293,995 jobs.

2.10 TOTAL IMPACT OF THE UNC SYSTEM

The total economic impact of the UNC system on North Carolina can be generalized into two broad types of impacts. First, on an annual basis, the UNC system generates a flow of spending that has a significant impact on the North Carolina economy. The impacts of this spending are captured by the operations, research, construction, clinical, extension, student, and visitor spending impacts. While not insignificant, these impacts don't capture the true impact or purpose of the UNC system. The basic purpose of UNC universities is to foster human capital. The skills, talents, creativity,

TABLE 2.20: TOTAL IMPACT OF UNC UNIVERSITIES (WITHOUT SPIN-OFF COMPANIES), FY 2012-13

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS		JOB EQUIVALENTS
Operations spending	$3,651,835		$243,011		$3,894,846		54,832
Clinical spending	$1,711,841		$585,778		$2,297,619		27,759
Research spending	$1,161,110		$382,842		$1,543,953		22,094
Construction spending	$273,005		-$99,824		$173,181		6,349
Start-up companies	$706,543		$713,678		$1,420,221		7,712
Extension spending	$86,490		$25,573		$112,063		1,459
Student spending	$135,076		$158,518		$293,595		5,377
Visitor spending	$156,962		$96,413		$253,375		6,474
Alumni	$13,828,117		$4,048,350		$17,876,467		293,995
Total impact	**$21,710,979**		**$6,154,339**		**$27,865,319**		**426,052**
% OF NORTH CAROLINA ECONOMY	**8.9%**		**3.2%**		**6.4%**		**7.9%**

Source: EMSI impact model.

imagination, and entrepreneurship embodied in the human capital of UNC universities are further brought to the market through numerous start-up companies. Every year a new cohort of UNC universities' alumni add to the stock of human capital in North Carolina, and a portion of alumni continue to contribute to the North Carolina economy. This is demonstrated by the hundreds of thousands of alumni UNC universities have served over the past 30 years who remain active in the state workforce.

Table 2.20 displays the grand total impacts the UNC system on the North Carolina economy in FY 2012-13 – including the impacts from operations spending, clinical spending, research spending, start-up companies, extension spending, student spending, visitor spending, and alumni. For context, the percentages of the UNC system compared to the total labor income, non-labor income, total added income, and job equivalents in North Carolina, as presented in Table 1.5, are included.

CHAPTER 3
INVESTMENT ANALYSIS

The benefits generated by UNC universities affect the lives of many people. The most obvious beneficiaries are the universities' students; they give up time and money to go to the universities in return for a lifetime of higher income and improved quality of life. But the benefits do not stop there. As students earn more, communities and citizens throughout North Carolina benefit from an enlarged economy and a reduced demand for social services. In the form of increased tax revenues and public sector savings, the benefits of education extend as far as the state and local government.

Investment analysis is the process of evaluating total costs and measuring these against total benefits to determine whether or not a proposed venture will be profitable. If benefits outweigh costs, then the investment is worthwhile. If costs outweigh benefits, then the investment will lose money and is thus considered infeasible. In this section, we consider UNC universities as a worthwhile investment from the perspectives of students, society, and taxpayers.

3.1 STUDENT PERSPECTIVE

To enroll in postsecondary education, students pay money for tuition and forgo monies that they would have otherwise 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 monies that students pay in the form of tuition and fees and the opportunity costs of forgone time and money. The benefits are the higher earnings that students receive as a result of their education.

3.1.1 Calculating student costs

Student costs consist of two main items: direct outlays and opportunity costs. Direct outlays include tuition and fees, equal to $1.4 billion from Table 1.2. Direct outlays also include the

cost of books and supplies. On average, full-time students spent $1,141 each on books and supplies during the reporting year.[18] Multiplying this figure times the number of full-time equivalents (FTEs) produced by UNC universities in FY 2012-13[19] generates a total cost of $250.9 million for books and supplies.

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

We derive the students' full earning potential by weighting the average annual income levels in Table 1.7 according to the education level breakdown of the student population when they first enrolled.[20] However, the income levels in Table 1.7 reflect what average workers earn at the midpoint of their careers, not while attending the universities. Because of this, we adjust the income levels to the average age of the student population (24) to better reflect their wages at their current age.[21] This calculation yields an average full earning potential of $28,826 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 students' CHE production as a proxy for time, under the assumption that the more CHEs students earn, the less time they have to work, and, consequently, the greater their forgone earnings. Overall, students attending UNC universities earned an average of 7.4 CHEs per student (excluding personal enrichment students), which is approximately equal to 25% of a full academic year.[22] We thus include no more than $7,119 (or 25%) of the students' full earning potential in the opportunity cost calculations.

Another factor to consider is the students' employment status while enrolled in postsecondary education. Based on data supplied by the universities, approximately 46% of students are employed.[23] For the 54% that are not working, we assume that they are either seeking work or planning to seek work once they complete their educational goals (with the exception of personal enrichment students, who are not included in this calculation). By choosing to enroll, therefore, non-working students give up everything that they can potentially earn during the academic year (i.e., the $7,119). The total value of their forgone income thus comes to $3.2 billion.

Working students are able to maintain all or part of their income while enrolled. However, many of them hold jobs that pay less than statistical averages, usually because those are the only jobs they can find that accommodate their course schedule. These jobs tend to be at entry level, such as restaurant servers or cashiers. To account for this, we assume that working students hold jobs that pay 58% of what they

18 Based on the data supplied by UNC universities.

19 A single FTE is equal to 30 CHEs, so there were 223,228 FTEs produced by students in FY 2012-13, equal to 6.7 million CHEs divided by 30 (excluding the CHE production of personal enrichment students).

20 This is based on the number of students who reported their entry level of education to UNC universities. EMSI provided estimates in the event that the data was not available from the universities.

21 Further discussion on this adjustment appears in Appendix 5.

22 Equal to 7.4 CHEs divided by 30, the assumed number of CHEs in a full-time academic year.

23 EMSI provided an estimate of the percentage of students employed in the case the universities were unable to collect the data.

would have earned had they chosen to work full-time rather than go to the universities.[24] The remaining 42% comprises the percent of their full earning potential that they forgo. Obviously this assumption varies by person; some students forego more and others less. Since we don't know the actual jobs held by students while attending, the 42% in forgone earnings serves as a reasonable average.

Working students also give up a portion of their leisure time in order to attend higher education universities. According to the Bureau of Labor Statistics American Time Use Survey, students forgo up to 1.4 hours of leisure time per day.[25] Assuming that an hour of leisure is equal in value to an hour of work, we derive the total cost of leisure by multiplying the number of leisure hours foregone during the academic year by the average hourly pay of the students' full earning potential. For working students, therefore, their total opportunity cost comes to $1.7 billion, equal to the sum of their foregone income ($1.2 billion) and forgone leisure time ($488.4 million).

The steps leading up to the calculation of student costs appear in Table 3.1. Direct outlays amount to $1.7 billion, the sum of tuition and fees ($1.4 billion) and books and supplies ($250.9 million), less $24.1 million in direct outlays for personal enrichment students (these students are excluded from the cost calculations). Opportunity costs for working and non-working students amount to $4.5 billion, excluding $379.8 million in offsetting residual aid that is paid directly to students.[26] Summing direct outlays and opportunity costs together yields a total of $6.1 billion in student costs.

TABLE 3.1: STUDENT COSTS, FY 2012–13 (THOUSANDS)

DIRECT OUTLAYS	
Tuition and fees	$1,434,031
Books and supplies	$250,901
Less direct outlays of personal enrichment students	-$24,061
Total direct outlays	$1,660,872
OPPORTUNITY COSTS	
Earnings forgone by non-working students	$3,151,231
Earnings forgone by working students	$1,204,907
Value of leisure time forgone by working students	$488,439
Less residual aid	-$379,837
Total opportunity costs	$4,464,740
TOTAL STUDENT COSTS	**$6,125,611**

Source: Based on data supplied by UNC universities and outputs of the EMSI college impact model.

3.1.2 Linking education to earnings

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

A key component in determining the stu-

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

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

26 Residual aid is the remaining portion of scholarship or grant aid distributed directly to a student after the universities apply tuition and fees.

dents' 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 universities' 2012-13 students first by determining their average annual increase in income, equal to $1.3 billion. This value represents the higher income that accrues to students at the midpoint of their careers and is calculated based on the marginal wage increases of the CHEs that students complete while attending the universities. For a full description of the methodology used to derive the $1.3 billion, see Appendix 5.

The second step is to project the $1.3 billion annual increase in income 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.[27] 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 US 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 United States based Mincer coefficients estimated by Polachek (2003). To account for any upward bias, we incorporate a 10% reduction in our projected earnings. With the $1.3 billion 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 3.2 on the next page.

As shown in Table 3.2, the $1.3 billion in gross added income occurs around Year 16, 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 added income that accrues to students in the years leading up to the midpoint is less than $1.3 billion and the gross added income in the years after the midpoint is greater than $1.3 billion.

The final step in calculating the students' future benefits stream is to net out the potential benefits generated by students who are either not yet active in the workforce or who leave the workforce over time. This adjustment appears in Column 3 of Table 3.2 and represents the percentage of the 2012-13 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 universities or because they are unable to find a job immediately upon graduation. Accordingly, we apply a set of "settling-in" factors to account for the time needed by students to find employment and settle into their careers. As discussed in Section 2, settling-in factors delay the onset of the benefits by one to three years for students who graduate with a certificate or a degree and by one to five years for degree-seeking students who do not complete during the analysis year.

27 Appendix 5 provides more information on the Mincer function and how it is used to predict future earnings growth.

TABLE 3.2: PROJECTED BENEFITS AND COSTS, STUDENT PERSPECTIVE

1	2	3	4	5	6
YEAR	GROSS ADDED INCOME TO STUDENTS (MILIONS)	LESS ADJUSTMENTS (MILLIONS)*	NET ADDED INCOME TO STUDENTS (MILLIONS)	STUDENT COSTS (MILLIONS)	NET CASH FLOW (MILLIONS)
0	$781	12%	$96	$6,126	-$6,030
1	$815	40%	$322	$0	$322
2	$848	48%	$406	$0	$406
3	$883	60%	$526	$0	$526
4	$917	75%	$684	$0	$684
5	$951	93%	$887	$0	$887
6	$985	93%	$920	$0	$920
7	$1,018	94%	$953	$0	$953
8	$1,052	94%	$985	$0	$985
9	$1,085	94%	$1,017	$0	$1,017
10	$1,117	94%	$1,048	$0	$1,048
11	$1,149	94%	$1,079	$0	$1,079
12	$1,180	94%	$1,108	$0	$1,108
13	$1,210	94%	$1,137	$0	$1,137
14	$1,240	94%	$1,164	$0	$1,164
15	$1,268	94%	$1,190	$0	$1,190
16	$1,295	94%	$1,215	$0	$1,215
17	$1,321	94%	$1,238	$0	$1,238
18	$1,345	94%	$1,260	$0	$1,260
19	$1,368	94%	$1,280	$0	$1,280
20	$1,389	93%	$1,298	$0	$1,298
21	$1,409	93%	$1,313	$0	$1,313
22	$1,427	93%	$1,327	$0	$1,327
23	$1,443	93%	$1,339	$0	$1,339
24	$1,458	92%	$1,348	$0	$1,348
25	$1,470	92%	$1,355	$0	$1,355
26	$1,481	92%	$1,360	$0	$1,360
27	$1,489	91%	$1,362	$0	$1,362
28	$1,496	91%	$1,362	$0	$1,362
29	$1,500	91%	$1,359	$0	$1,359
30	$1,502	90%	$1,354	$0	$1,354
31	$1,502	90%	$1,346	$0	$1,346
32	$1,500	89%	$1,336	$0	$1,336
33	$1,496	88%	$1,323	$0	$1,323
34	$1,490	88%	$1,308	$0	$1,308
35	$1,482	87%	$1,290	$0	$1,290
36	$1,472	85%	$1,254	$0	$1,254
37	$1,460	84%	$1,226	$0	$1,226
38	$1,446	81%	$1,165	$0	$1,165
39	$1,402	78%	$1,095	$0	$1,095
40	$1,354	58%	$788	$0	$788
41	$1,304	27%	$348	$0	$348
42	$1,178	14%	$162	$0	$162
43	$727	6%	$44	$0	$44
44	$111	12%	$13	$0	$13
45	$7	26%	$2	$0	$2
PRESENT VALUE			**$19,204**	**$6,126**	**$13,079**
Internal rate of return					13.7%
Benefit-cost ratio					3.1
Payback period (no. of years)					9.3

** Includes the "settling-in" factors and attrition. Percentages reflect aggregate values for all universities and are subject to fluctuations due to the universities' varying time horizons.*

Source: EMSI impact model.

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 economic impact analysis of Section 2.[28] 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 3.2 shows the net added income to students after accounting for both the settling-in patterns and attrition.

3.1.3 Return on investment to students

Having estimated the students' costs and their future benefits stream, the next step is to discount the results to the present to reflect the time value of money. For the student perspective we assume a discount rate of 4.5% (see below). Because students tend to rely upon debt to pay for their educations – i.e. they are negative savers – their discount rate is based upon student loan interest rates. [29] In Section 4, 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, a rate of return that exceeds the discount rate, and a reasonably short payback period.

In Table 3.2, the net added income of students yields a cumulative discounted sum of approximately $19.2 billion, the present value of all of the future income increments (see the bottom section of Column 4). This may also be interpreted as the gross capital asset value of the students' higher income stream. In effect, the aggregate 2012-13 student body is rewarded for its investment in UNC universities with a capital asset valued at $19.2 billion.

The students' cost of attending the universities is shown in Column 5 of Table 3.2, equal to a present value of $6.1 billion. Note that costs occur only in the single analysis year and are thus already in current year dollars. Comparing the cost with the present value of benefits yields a student benefit-cost ratio of 3.1 (equal to $19.2 billion in benefits divided by $6.1 billion in costs).

Another way to compare the same benefits stream and associated cost is to compute the rate of return. The rate of return indicates the interest rate that a bank would have to pay a depositor to yield an equally attractive stream of future payments.[30] Table 3.2 shows students of UNC universities earning average returns of 13.7% on their investment of time and money.

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

29 The student discount rate is derived from the baseline forecasts for the 10-year zero coupon bond discount rate published by the Congressional Budget Office. See the Congressional Budget Office, Student Loan and Pell Grant Programs - March 2012 Baseline, Congressional Budget Office Publications, last modified March 13, 2012, accessed July 2013, http://www.cbo.gov/sites/default/files/cbofiles/attachments/43054_StudentLoanPellGrantPrograms.pdf.

30 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.

This is a favorable return compared, for example, to approximately 1% on a standard bank savings account, or 7% on stocks and bonds (30-year average return).

Note that returns reported in this study are real returns, not nominal. When a bank promises to pay a certain rate of interest on a savings account, it employs an implicitly nominal rate. Bonds operate in a similar manner. If it turns out that the inflation rate is higher than the stated rate of return, then money is lost in real terms. In contrast, a real rate of return is on top of inflation. For example, if inflation is running at 3% and a nominal percentage of 5% is paid, then the real rate of return on the investment is only 2%. In Table 3.2, the 13.7% student rate of return is a real rate. With an inflation rate of 2.5% (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 16.2%, higher than what is reported in Table 3.2.

The payback period is defined as the length of time it takes to entirely recoup the initial investment.[31] Beyond that point, returns are what economists would call pure costless rent. As indicated in Table 3.2, students at UNC universities see, on average, a payback period of 9.3 years on their forgone earnings and out-of-pocket costs.

3.2 SOCIETAL PERSPECTIVE

North Carolina benefits from the education that UNC universities provide through the income that students create in the state and through the savings that they generate through their improved lifestyles. To receive these benefits, however, members of society must pay money and forgo services that they would have otherwise enjoyed if UNC universities did not exist. Society's investment in UNC universities stretches across a number of investor groups, from students to employers to taxpayers. We weigh the benefits generated by UNC universities to these investor groups against the total societal costs of generating those benefits. The total societal costs include all expenses of UNC universities except those for clinical and construction operations, all student expenses less tuition and fees, and all student opportunity costs, totaling $11.9 billion ($7.2 billion in expenses of UNC universities, $226.8 million in student expenses, and $4.5 billion in student opportunity costs).

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

3.2.1 Income growth in the state

In the process of absorbing the newly-acquired skills of students that attend UNC universities, not only does the productivity of North Carolina' workforce increase, but also does the productivity of its physical capital and assorted

31 Payback analysis is generally used by the business community to rank alternative investments when safety of investments is an issue. Its greatest drawback is that it takes no account of the time value of money. The payback period is calculated by dividing the cost of the investment by the net return per period. In this study, the cost of the investment includes tuition and fees plus the opportunity cost of time; it does not take into account student living expenses or interest on loans.

infrastructure. Students earn more because of the skills they learned while attending the universities, 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.

BEEKEEPER ANALOGY

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

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

Educational institutions are like beekeepers. While their principal aim is to provide education and raise people's incomes, in the process an array of external benefits are created. Students' health and lifestyles are improved, and society indirectly benefits just as orchard owners indirectly benefit from beekeepers. Aiming at a more complete accounting of the benefits generated by education, the model tracks and accounts for many of these external societal benefits.

Estimating the effect of UNC universities on income growth in the state begins with the present value of the students' future income stream, which is displayed in Column 4 of Table 3.2. To this we apply a multiplier derived from EMSI's SAM model to estimate the added labor income created in the state as students and businesses spend their higher incomes.[32] 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. We also include the spending impacts discussed in Section 2 that were created in 2012-13 by the operations of the universities and their research and extension activities, as well as spending from students and visitors.

The sum of the students' higher incomes, multiplier effect, increase in non-labor income, and spending impacts comprises the gross added income that accrues to communities and citizens throughout the state of North Carolina. Not all of this income may be counted as benefits to the state, however. Some students leave the state during the course of their careers, and the higher income they receive as a result of their education leaves the state with them. To account for this dynamic, we combine student settlement data from the universities with data on migration patterns from the U.S. Census Bureau 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 in Section 2 and is designed to account

32 For a full description of the EMSI SAM model, see Appendix 3.

for the counterfactual scenario where UNC universities do not exist. The assumption in this case is that any benefits generated by students who could have received an education even without the universities cannot be counted as new benefits to society. For this analysis, we assume an alternative education variable of 15%, meaning that 15% of the student population at the universities would have generated benefits anyway even without the universities. For more information on the calculation of the alternative education variable, see Appendix 6.

After adjusting for attrition and alternative education opportunities, we calculate the present value of the future added income that occurs in the state, equal to $93.1 billion (this value appears again later in Table 3.3). Recall from the discussion of the student return on investment that the present value represents the sum of the future benefits that accrue each year over the course of the time horizon, discounted to current year dollars to account for the time value of money. Given that the stakeholder in this case is the public sector, we use the discount rate of 1.1%, the real treasury interest rate recommended by the Office for Management and Budget (OMB) for 30-year investments.[33] In Section 4, we conduct a sensitivity analysis of this discount rate.

3.2.2 Social savings

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

TABLE 3.3: PRESENT VALUE OF THE FUTURE ADDED INCOME AND SOCIAL SAVINGS IN THE STATE (THOUSANDS)

ADDED INCOME	**$93,126,817**
SOCIAL SAVINGS	
Health	
Smoking	$6,706,023
Alcoholism	$223,728
Obesity	$4,386,127
Mental illness	$1,634,975
Drug abuse	$422,017
Total health savings	**$13,372,870**
CRIME	
Criminal Justice System savings	$177,958
Crime victim savings	$15,821
Added productivity	$59,081
Total crime savings	**$252,860**
WELFARE/UNEMPLOYMENT	
Welfare savings	$5,663
Unemployment savings	$7,793
Total welfare/unemployment savings	**$13,456**
TOTAL SOCIAL SAVINGS	**$13,639,186**
TOTAL, ADDED INCOME + SOCIAL SAVINGS	**$106,766,003**

Source: EMSI impact model.

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

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

The model quantifies social savings by calculating the probability at each education level that individuals will have poor health, commit crimes, or claim welfare and unemployment benefits. Deriving the probabilities involves assembling data from a variety of studies and surveys analyzing the correlation between education and health, crime, welfare, and unemployment at the national 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 at the universities, will not have poor health, commit crimes, or claim welfare and unemployment benefits. We dampen these results by the ability bias adjustment discussed earlier in this section and in Appendix 5 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, welfare, and unemployment.[34] Finally, we apply the same adjustments for attrition and alternative education to derive the net savings to society.

Table 3.3 above displays the results of the analysis. The first row shows the added income created in the state, equal to $93.1 billion, from students' higher incomes and their multiplier effect, increase in non-labor income, and spending impacts. Social savings appear next, beginning with a breakdown of savings related to health. These savings amount to a present value of $13.4 billion, including savings due to a reduced demand for medical treatment and social services, improved worker productivity and reduced absenteeism, and a reduced number of vehicle crashes and fires induced by alcohol or smoking-related incidents. Crime savings amount to $252.9 million, including savings associated with a reduced number of crime victims, added worker productivity, and reduced expenditures for police and law enforcement, courts and administration of justice, and corrective services. Finally, the present value of the savings related to welfare and unemployment amount to $13.5 million, stemming from a reduced number of persons in need of income assistance. All told, social savings amounted to $13.6 billion in benefits to communities and citizens in North Carolina.

The sum of the social savings and the added income in the state is $106.8 billion, as shown in the bottom row of Table 3.3. These savings accrue in the future as long as the 2012-13 student population of UNC universities remains in the workforce.

3.2.3 Return on investment to society

Table 3.4 on the following page presents the stream of benefits accruing to North Carolina society and the total societal costs of generating those benefits. Comparing the present value of the benefits and the societal costs, we have a benefit-cost ratio of 8.9. This means that for every dollar invested in an education by UNC universities, whether it is the money spent on day-to-day operations of the universities or money spent by students on tuition and fees, an average of $8.90 in benefits will accrue to society in North Carolina.[35]

34 For a full list of the data sources used to calculate the societal externalities, see the References and Resource section. See also Appendix 8 for a more in-depth description of the methodology.

35 The rate of return is not reported for the societal perspective because the beneficiaries of the investment are not necessarily the same as the original investors.

TABLE 3.4: PROJECTED BENEFITS AND COSTS, SOCIETAL PERSPECTIVE

1	2	3	4
YEAR	BENEFITS TO SOCIETY (MILLIONS)	SOCIETAL COSTS (MILLIONS)	NET CASH FLOW (MILLIONS)
0	$6,962	$11,936	-$4,974
1	$966	$0	$966
2	$1,221	$0	$1,221
3	$1,595	$0	$1,595
4	$2,085	$0	$2,085
5	$2,705	$0	$2,705
6	$2,775	$0	$2,775
7	$2,844	$0	$2,844
8	$2,911	$0	$2,911
9	$2,977	$0	$2,977
10	$3,041	$0	$3,041
11	$3,103	$0	$3,103
12	$3,162	$0	$3,162
13	$3,220	$0	$3,220
14	$3,274	$0	$3,274
15	$3,325	$0	$3,325
16	$3,374	$0	$3,374
17	$3,418	$0	$3,418
18	$3,459	$0	$3,459
19	$3,496	$0	$3,496
20	$3,529	$0	$3,529
21	$3,558	$0	$3,558
22	$3,582	$0	$3,582
23	$3,601	$0	$3,601
24	$3,615	$0	$3,615
25	$3,625	$0	$3,625
26	$3,629	$0	$3,629
27	$3,628	$0	$3,628
28	$3,622	$0	$3,622
29	$3,610	$0	$3,610
30	$3,593	$0	$3,593
31	$3,571	$0	$3,571
32	$3,543	$0	$3,543
33	$3,509	$0	$3,509
34	$3,470	$0	$3,470
35	$3,425	$0	$3,425
36	$3,331	$0	$3,331
37	$3,261	$0	$3,261
38	$3,085	$0	$3,085
39	$2,891	$0	$2,891
40	$2,011	$0	$2,011
41	$898	$0	$898
42	$432	$0	$432
43	$121	$0	$121
44	$30	$0	$30
45	$3	$0	$3
PRESENT VALUE	**$106,766**	**$11,936**	**$94,830**
Benefit-cost ratio			8.9
Payback period (no. of years)			4.6

** Includes the "settling-in" factors and attrition. Percentages reflect aggregate values for all universities and are subject to fluctuations due to the universities' varying time horizons.*
Source: EMSI impact model.

TABLE 3.5: PRESENT VALUE OF ADDED TAX REVENUE AND GOVERNMENT SAVINGS (THOUSANDS)

ADDED INCOME FROM UNC UNIVERSITIES	
Added tax revenue	**$8,973,682**
GOVERNMENT SAVINGS	
Health-related savings	$2,229,477
Crime-related savings	$185,889
Welfare/unemployment-related savings	$13,456
Total government savings	**$2,428,822**
TOTAL TAXPAYER BENEFITS	**$11,402,504**

Source: EMSI impact model.

3.3 TAXPAYER PERSPECTIVE

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

3.3.1 Benefits to taxpayers

Table 3.5 presents the total added income from the universities and the present value of the benefits to taxpayers. Added tax revenue is derived by multiplying the income growth figures from Table 3.3 by the prevailing state and local government tax rates. For the societal externalities, we claim only the benefits that reduce the demand for government-supported social services, or the benefits resulting from improved productivity among government employees. The present value of future tax revenues and government savings thus comes to approximately $11.4 billion.

3.3.2 Return on investment to taxpayers

Taxpayer costs are reported in Table 3.6 on the following page and come to $2.9 billion, equal to the contribution of state and local government to UNC universities (including capital appropriations but excluding clinical appropriations). In return for their public support, taxpayers are rewarded with an investment benefit-cost ratio of 3.9 (= $11.4 billion ÷ $2.9 billion), indicating a profitable investment.

At 11.8%, the rate of return to state and local taxpayers is also favorable. As above, we assume a 1.1% discount rate when dealing with government investments and public finance issues.[36] This is the return governments are assumed to be able to earn on generally safe investments of unused funds, or alternatively, the interest rate for which governments, as relatively safe borrowers, can obtain funds. A rate of return of 1.1% would mean that the universities just

36 See Section 4 for a sensitivity analysis of this discount rate.

TABLE 3.6: PROJECTED BENEFITS AND COSTS, TAXPAYER PERSPECTIVE

1	2	3	4
YEAR	BENEFITS TO TAXPAYERS (MILLIONS)	STATE AND LOCAL GOV'T COSTS (MILLIONS)	NET CASH FLOW (MILLIONS)
0	$668	$2,942	-$2,274
1	$108	$0	$108
2	$135	$0	$135
3	$176	$0	$176
4	$230	$0	$230
5	$298	$0	$298
6	$305	$0	$305
7	$311	$0	$311
8	$318	$0	$318
9	$324	$0	$324
10	$330	$0	$330
11	$336	$0	$336
12	$342	$0	$342
13	$348	$0	$348
14	$353	$0	$353
15	$358	$0	$358
16	$363	$0	$363
17	$367	$0	$367
18	$371	$0	$371
19	$374	$0	$374
20	$378	$0	$378
21	$380	$0	$380
22	$383	$0	$383
23	$384	$0	$384
24	$386	$0	$386
25	$386	$0	$386
26	$387	$0	$387
27	$386	$0	$386
28	$386	$0	$386
29	$384	$0	$384
30	$383	$0	$383
31	$380	$0	$380
32	$377	$0	$377
33	$374	$0	$374
34	$370	$0	$370
35	$365	$0	$365
36	$355	$0	$355
37	$348	$0	$348
38	$329	$0	$329
39	$308	$0	$308
40	$215	$0	$215
41	$96	$0	$96
42	$46	$0	$46
43	$13	$0	$13
44	$3	$0	$3
45	$1	$0	$1
PRESENT VALUE	**$11,403**	**$2,942**	**$8,461**
Internal rate of return			11.8%
Benefit-cost ratio			3.9
Payback period (no. of years)			10.2

** Includes the "settling-in" factors and attrition. Percentages reflect aggregate values for all universities and are subject to fluctuations due to the universities' varying time horizons.*
Source: EMSI impact model.

pay their own way. In principle, governments could borrow monies used to support UNC universities and repay the loans out of the resulting added taxes and reduced government expenditures. A rate of return of 11.8%, on the other hand, means that UNC universities not only pay their own way, but also generate a surplus that state and local government can use to fund other programs. It is unlikely that other government programs could make such a claim.

3.3.3 With and without social savings

Earlier in this section, societal benefits attributable to education (reduced crime, lower welfare, lower unemployment, and improved health) were defined as externalities that are incidental to the operations of UNC universities. Some would question the legitimacy of including these benefits in the calculation of rates of return to education, arguing that only the tangible benefits (higher income) should be counted. Tables 3.4 and 3.6 are inclusive of societal benefits reported as attributable to UNC universities. Recognizing the other point of view, Table 3.7 shows rates of return for both the societal and taxpayer perspectives exclusive of societal benefits. As indicated, returns are still above threshold values (a benefit-cost ratio greater than 1.0 and a rate of return greater than 1.1%), confirming that taxpayers receive value from investing in UNC universities.

3.4 CONCLUSION

This section has shown that the education provided by UNC universities is an attractive investment to students with rates of return that exceed alternative investment opportunities. At the same time, the presence of the universities expands the state economy and creates a wide range of positive societal benefits that accrue to taxpayers and communities in North Carolina.

TABLE 3.7: SOCIETAL AND TAXPAYER PERSPECTIVES WITH AND WITHOUT SOCIAL SAVINGS

	INCLUDING SOCIAL SAVINGS	EXCLUDING SOCIAL SAVINGS
SOCIETAL PERSPECTIVE		
Net present value	$94,830,152	$74,586,408
Benefit-cost ratio	8.9	7.2
TAXPAYER PERSPECTIVE		
Net present value	$8,460,676	$6,031,855
Benefit-cost ratio	3.9	3.1
Internal rate of return	11.8%	9.1%
Payback period (no. of years)	10.2	12.7

Source: EMSI impact model.

CHAPTER 4
SENSITIVITY ANALYSIS

Sensitivity analysis is the process by which researchers determine how sensitive the outputs of the model are to variations in the background data and assumptions, especially if there is any uncertainty in the variables. Sensitivity analysis is also useful for identifying a plausible range wherein the results will fall should any of the variables deviate from expectations. In this section 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, and 4) the discount rate.

4.1 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 publicly-funded universities in the state. Given the difficulty in accurately specifying the alternative education variable, we test the sensitivity of the taxpayer and societal investment analysis results to its magnitude. Variations in the alternative education assumption are calculated around base case results listed in the middle column of Table 4.1 on the next page. 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 redone 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 perspective rate of return from 11.8% to 11.6%. Likewise, a decrease of 10% (from 15% to 14%) in the assumption increases the rate of return from 11.8% to 12.0%.

Based on this sensitivity analysis, the conclusion can be drawn that UNC universities investment analysis results from the taxpayer and societal perspectives are not very sensitive to relatively large variations in the alternative education variable. As indicated, results are still above their threshold levels (net present value greater than 0, benefit-cost ratio greater

TABLE 4.1: SENSITIVITY ANALYSIS OF ALTERNATIVE EDUCATION VARIABLE, TAXPAYER AND SOCIETAL PERSPECTIVE

% VARIATION IN ASSUMPTION	-50%	-25%	-10%	BASE CASE	10%	25%	50%
Alternative education variable	8%	11%	14%	15%	17%	19%	23%
SOCIETAL PERSPECTIVE							
Net present value (millions)	$104,093	$99,390	$96,567	$94,830	$92,804	$89,982	$85,278
Benefit-cost ratio	9.7	9.3	9.1	8.9	8.8	8.5	8.1
TAXPAYER PERSPECTIVE							
Net present value (millions)	$9,467	$8,964	$8,662	$8,461	$8,259	$7,958	$7,455
Rate of return	13%	12%	12%	12%	12%	11%	11%
Benefit-cost ratio	4.2	4.0	3.9	3.9	3.8	3.7	3.5

TABLE 4.2: 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)	$8,938	$13,407	$16,089	$17,876	$19,664	$22,346	$26,815

than 1, and rate of return greater than the discount rate of 1.1%), even when the alternative education assumption is increased by as much as 50% (from 15% to 23%). The conclusion is that although the assumption is difficult to specify, its impact on overall investment analysis results for the taxpayer and societal perspective is not very sensitive.

4.2 LABOR IMPORT EFFECT VARIABLE

The labor import effect variable only affects the alumni impact calculation in Table 2.18. In the model we assume a labor import effect variable of 50%, which means that we claim only 50% of the initial labor income generated by increased alumni productivity. The other 50% we assume would have been created in the state anyway – even without UNC universities – since the businesses that hired UNC universities' students could have substituted some of these workers with equally-qualified people from outside the state had there been no students from UNC universities to hire.

Table 4.2 presents the results of the sensitivity analysis for the labor import effect variable. As above, the assumption increases and decreases relative to the base case of 50% by the increments indicated in the table. Alumni impacts attributable to UNC universities, for example, range from a low of $8.9 billion at a -50% variation to a high of $26.8 billion 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 and past student productivity increases as well. The impact stemming from the alumni still remains a sizeable factor in the North Carolina economy, even under the most conservative assumptions.

4.3 STUDENT EMPLOYMENT VARIABLES

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

Students incur substantial expense by attending UNC universities 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 46% of students who reported their employment status are employed, based on data provided by UNC universities.[37] This variable is tested in the sensitivity analysis by changing it first to 100% and then to 0%.

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

The changes generate results summarized in Table 4.3, with A defined as the percent of students employed and B defined as the percent that students earn relative to their full

37 EMSI provided an estimate of the percentage of students employed in the event that the universities were unable to collect the data.

TABLE 4.3: SENSITIVITY ANALYSIS OF STUDENT EMPLOYMENT VARIABLES

VARIATIONS IN ASSUMPTIONS	NET PRESENT VALUE (MILLIONS)	INTERNAL RATE OF RETURN	BENEFIT-COST RATIO
Base case: A = 46%, B = 58%	$13,078.7	13.7%	3.1
Scenario 1: A = 100%, B = 58%	$14,352.2	16.4%	4.0
Scenario 2: A = 46%, B = 100%	$14,283.6	16.2%	3.9
Scenario 3: A = 100%, B = 100%	$16,893.2	29.1%	8.3
Scenario 4: A = 0%, B = 0%	$11,930.3	11.9%	2.6

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

earning potential. Base case results appear in the shaded row; here the assumptions remain unchanged, with A equal to 46% and B equal to 58%. 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%.

- **Scenario 1:** Increasing the percentage of students employed (A) from 46% to 100%, the net present value, internal rate of return, and benefit-cost ratio improve to $14.4 billion, 16.4%, and 4.0, 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 58% to 100%, the net present value, internal rate of return, and benefit-cost ratio results improve to $14.3 billion, 16.2%, and 3.9, 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 $16.9 billion, 29.1%, and 8.3, 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 $11.9 billion, 11.9%, and 2.6, respectively, relative to base case results. These results are reflective of an increased opportunity cost; none of the students are employed in this case.[38]

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 Section 3 are realistic, indicating that investments in UNC universities generate excellent returns, well above the long-term average percent rates of return in stock and bond markets.

4.4 DISCOUNT RATE

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

38 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.

TABLE 4.4: SENSITIVITY ANALYSIS OF DISCOUNT RATE

% VARIATION IN ASSUMPTION	-50%	-25%	-10%	BASE CASE	10%	25%	50%
STUDENT PERSPECTIVE							
Discount rate	2.2%	3.4%	4.0%	4.5%	4.9%	5.6%	6.7%
Net present value (millions)	$22,657	$17,206	$14,597	$13,079	$11,713	$9,911	$9,077
Benefit-cost ratio	4.7	3.8	3.4	3.1	2.9	2.6	2.5
SOCIETAL PERSPECTIVE							
Discount rate	0.6%	0.8%	1.0%	1.1%	1.2%	1.4%	1.7%
Net present value (millions)	$106,992	$100,683	$97,119	$94,830	$92,609	$89,397	$84,349
Benefit-cost ratio	10.0	9.4	9.1	8.9	8.8	8.5	8.1
TAXPAYER PERSPECTIVE							
Discount rate	0.6%	0.8%	1.0%	1.1%	1.2%	1.4%	1.7%
Net present value (millions)	$9,762	$9,087	$8,706	$8,461	$8,223	$7,879	$7,339
Benefit-cost ratio	4.3	4.1	4.0	3.9	3.8	3.7	3.5

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 1.1% discount rate for society and taxpayers.[39] Similar to the sensitivity analysis of the alternative education variable, we vary the base case discount rates for students, society, and taxpayers on either side by increasing the discount rate by 10%, 25%, and 50%, and then reducing it by 10%, 25%, and 50%. Note that, because the rate of return and the payback period are both based on the undiscounted cash flows, they are unaffected by changes in the discount rate. As such, only variations in the net present value and the benefit-cost ratio are shown for students, society, and taxpayers in Table 4.4.

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 6.7%) reduces the students' benefit-cost ratio from 3.1 to 2.5. Conversely, reducing the discount rate for students by 50% (from 4.5% to 2.2%) increases the benefit-cost ratio from 3.1 to 4.7. The sensitivity analysis results for society and taxpayers show the same inverse relationship between the discount rate and the benefit-cost ratio, with the variance in results being the greatest under the societal perspective (from a 10.0 benefit-cost ratio at a -50% variation from the base case, to a 8.1 benefit-cost ratio at a 50% variation from the base case).

39 These values are based on the baseline forecasts for the 10-year zero coupon bond discount rate published by the Congressional Budget Office, and the real treasury interest rates recommended by the Office for Management and Budget (OMB) for 30-year investments. See the Congressional Budget Office, Student Loan and Pell Grant Programs - March 2012 Baseline, and the Office of Management and Budget, Circular A-94 Appendix C, last modified December 2012.

RESOURCES & REFERENCES

Administration for Children and Families. Characteristics and Financial Circumstances of TANF Recipients, Fiscal Year 2010. August 2012. Accessed July 2013. http://www.acf.hhs.gov/sites/default/files/ofa/appendix_ys_final.pdf.

Administration for Children and Families. "Fiscal Year 2011 TANF Financial Data." Office of Family Assistance, TANF Financial Data. Updated August 2012. Accessed August 2013. http://www.acf.hhs.gov/programs/ofa/resource/tanf-financial-data-fy-2011.

American Automobile Association. "AAA Average Costs Per Mile" in "Your Driving Costs." AAA Association Communication: 2012. Accessed May 2012. http://newsroom.aaa.com/wp-content/uploads/2012/04/YourDrivingCosts2012.pdf.

American Community Survey. "Commuting in the United States: 2009" in "American Community Survey Reports." U.S. Department of Commerce Economics and Statistics Administration, September 2011.

Baryla, Edward and Douglas Dotterweich. "Student Migration: Do Significant Factors Vary by Region?" *Education Economics* 9, no. 3 (2001).

Becker, Gary S. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education.* New York: Columbia College Press for NBER, 1964.

Bilkic, Natasa, Thomas Gries, and Margarethe Pilichowski. "Stay in school or start working? – The human capital investment decision under uncertainty and irreversibility." *Labour Economics* 19, no. 5 (October 2012): 706-717.

Bouchery, Ellen, Carol Simon, and Hendrick Harwood. "Economic Costs of Excessive Alcohol Consumption in the United States, 2006." The Lewin Group, February 2013. Report prepared for the Centers for Disease Control and Prevention and the National Foundation for the Centers for Disease Control and Prevention. Accessed August 2013. http://www.lewin.com/~/media/Lewin/Site_Sections/Publications/CDC_Report_Rev.pdf.

Bureau of Justice Statistics. "Appendix Table 1 - Prisoners under the jurisdiction of state or federal correctional authorities, by jurisdiction, December 31, 2000, 2008, and 2009." in "Prisoners in 2009 (revised)." NCJ 231675, December 2010. Revised October 2011. Accessed July 2013. http://www.bjs.gov/content/pub/pdf/p09.pdf.

Bureau of Labor Statistics. "Charts by Topic:

Leisure and sports activities." American Time Use Survey. Last modified November 2012. Accessed July 2013. http://www.bls.gov/TUS/CHARTS/LEISURE.HTM.

Bureau of Labor Statistics. Consumer Price Index. Accessed January 2013. ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt.

Bureau of Labor Statistics. "Earnings and unemployment rates by educational attainment." BLS Employment Projections. Last modified May 2013. Accessed July 2013. http://www.bls.gov/emp/ep_chart_001.htm.

Bureau of Labor Statistics. "May 2012 National Occupational Employment and Wage Estimates United States." Occupational Employment Statistics. Accessed July 2013. http://www.bls.gov/oes/current/oes_nat.htm.

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

Bureau of Labor Statistics. "Table A-10. Unemployment rates by age, sex, and marital status, seasonally adjusted." Labor Force Statistics from the Current Population Survey. Last modified July 2013. Accessed July 2013. http://www.bls.gov/web/empsit/cpseea10.htm.

Buss, Christian, Jeffrey Parker, and Jon Rivenburg. "Cost, quality and enrollment demand at liberal arts colleges." *Economics of Education Review* 23, no.1 (February 2004): 57-65.

Card, David. "The causal effect of education on earnings." *Handbook of Labor Economics* 3 (1999): 1801-1863.

Card, David. "Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems." *Econometrica* 69, no.5 (September 2001): 1127-1160.

Carson, Ann E. and Daniela Golinelli. "Table 1: Prisoners under the jurisdiction of state or federal correctional authorities, December 31, 2002–2012" in "Prisoners in 2012 - Advance Counts." Bureau of Justice Statistics, July 2013, NCJ 242467. Accessed August 2013. http://www.bjs.gov/content/pub/pdf/p12ac.pdf.

Center on Budget and Policy Priorities. "Policy Basics - How many weeks of unemployment are available?" Updated August 26, 2013. Accessed August 27, 2013. http://www.cbpp.org/files/PolicyBasics_UI_Weeks.pdf.

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

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

Centers for Disease Control and Prevention. "Heavy drinkers (adult men having more than two drinks per day and adult women having more than one drink per day)" in "Alcohol Consumption - 2012." Behavioral Risk Factor Surveillance

System Prevalence and Trends Data. Accessed August 2013. http://apps.nccd.cdc.gov/brfss/list.asp?cat=AC&yr=2012&qkey=8381&state=All.

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

Centers for Disease Control and Prevention. "Table 3: Prevalence of current depression among adults aged ≥18 years, by sociodemographic characteristics and year – Behavioral Risk Factor Surveillance System, multiple states, 2006 and 2008" in "Mental Illness Surveillance Among Adults in the United States." *Morbidity and Mortality Weekly Report* 60 supplement (September 2011): 17.

Centers for Disease Control and Prevention. "Table 61. Age-adjusted prevalence of current cigarette smoking among adults aged 25 and over, by sex, race, and education level: United States, selected years 1974-2011." National Health Interview Survey, 2011. Accessed August 2013. http://www.cdc.gov/nchs/data/hus/2011/061.pdf.

College Board. "Figure 1: Average Estimated Full-Time Undergraduate Budgets, 2012-13 (Enrollment-Weighted)" in "Average Estimated Undergraduate Budgets, 2012-13." The College Board, Annual Survey of Colleges. Accessed August 2013. http://trends.collegeboard.org/college-pricing/figures-tables/average-estimated-undergraduate-budgets-2012-13.

Congressional Budget Office. Student Loan and Pell Grant Programs - March 2012 Baseline. Congressional Budget Office Publications. Last modified March 13, 2012. Accessed July 2013. http://www.cbo.gov/sites/default/files/cbofiles/attachments/43054_StudentLoanPellGrantPrograms.pdf.

Criminal Justice Expenditure and Employment Extracts Program (CJEE). "Table 4. Justice system expenditure by character, state and type of government, fiscal year 2009 (preliminary)." Justice Expenditure and Employment Extracts 2009 (preliminary), NCJ 237913. Accessed July 2013. http://bjs.ojp.usdoj.gov/index.cfm?ty=pbdetail&iid=4335.

Dickerson, Andy, and Steven McIntosh. "The Impact of Distance to Nearest Education Institution on the Post Compulsory Education Participation Decision." *Urban Studies* 50, no. 4 (2013): 742-758.

Dynarski, Susan M. "Does Aid Matter? Measuring the Effect of Student Aid on College Attendance and Completion." *American Economic Review* 93, no. 1 (2003): 279-288.

Economic Modeling Specialists, Intl. Labor market data and software. www.economicmodeling.com.

Federal Bureau of Investigation, Criminal Justice Information Services Division. "Table 12: Crime Trends by Population Group, 2009-2010" in "Uniform Crime Reports." Crime in the United States, Offenses Known to Law Enforcement. Accessed August 2013. http://www.fbi.

gov/about-us/cjis/ucr/crime-in-the-u.s/2010/crime-in-the-u.s.-2010/offenses-known-to-law-enforcement.

Federal Bureau of Investigation, Criminal Justice Information Services Division. "Table 29: Estimated Number of Arrests, United States, 2010" in "Uniform Crime Reports." Crime in the United States, Persons Arrested. Accessed August 2013. http://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2010/crime-in-the-u.s.-2010/tables/10tbl29.xls.

Federal Bureau of Prisons. "Quick Facts About the Bureau of Prisons." Last updated July 27, 2013. Accessed August 19, 2013. http://www.bop.gov/news/quick.jsp#1.

Finkelstein, Eric A., 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.

Guerino, Paul, Paige M. Harrison, and William J. Sabol. "Prisoners in 2010." Bureau of Justice Statistics, December 2011, NCJ 236096. Accessed August 2013. http://www.bjs.gov/content/pub/pdf/p10.pdf.

Hamadeh, Mohamad and Roy Khoueiri. "Demand Elasticities for Higher Education in the United States." *International Journal of Business and Economic Perspectives* 5, no. 2 (2010): 60-67.

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

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

IHS Consulting. "North Carolina Tourism 2011." Accessed March 27, 2013. http://www.travelks.com/includes/content/docs/media/2011-North Carolina-TSA-Results-with-Regional-Analysis.pdf.

Jaeger, David A. and Marianne E. Page. "New Evidence on Sheepskin Effects in the Returns to Education." *The Review of Economics and Statistics* 78, no. 4 (November 1996): 733-740.

Kelchtermans, Stijn and Frank Verboven. "Participation and Study Decisions in a Public System of Higher Education." *Journal of Applied Econometrics* 25, no.3 (2010): 355-391.

Knapp, Laura G., Janice E. Kelly-Reid, and Scott A. Ginder. "Table 1. Enrollment at all Title IV institutions, by control of institution, student level, level of institution, attendance status, gender, and race/ethnicity: United States, fall 2011" in *Enrollment in Postsecondary Institutions, Fall 2011; Financial Statistics, Fiscal Year 2011; and Graduation Rates, Selected Cohorts, 2003-2008*. Washington, DC: National Center for Education Statistics, December 2012. Accessed July 2013. http://nces.ed.gov/pubs2012/2012174rev.pdf.

Leigh, Andrew and Chris Ryan. "Estimating returns to education using different natural experiments techniques." *Economics of Education Review* 27 (2008): 149-160.

Leonesio, Michael V. "The Economics of

Retirement: A Nontechnical Guide." *Social Security Bulletin* 59 no. 4 (Winter 1996): 29-50.

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 1, 2010): 98-109. Accessed August 2013. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2835847/.

Mincer, Jacob. "Investment in Human Capital and Personal Income Distribution." *Journal of Political Economy* 66, no. 4 (August 1958): 281–302.

Mincer, Jacob. *Schooling, Experience and Earnings.* New York: National Bureau of Economic Research, 1974.

Minton, Todd. "Table 1: Inmates confined in local jails at midyear, average daily population, and incarceration rates, 2000–2012" in "Jail Inmates at Midyear 2012 - Statistical Tables." Bureau of Justice Statistics, May 2013, NCJ 241264. Accessed August 2013. www.bjs.gov/content/pub/pdf/jim12st.pdf.

Morgan, James N. and Edward H. Robb. "The impact of age upon interregional migration." *The Annals of Regional Science* 15, no. 3 (November 1981): 31-45.

National Center for Education Statistics. *Digest of Education Statistics: 2011.* Accessed July 2013. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2012001.

National Center for Education Statistics, Integrated Post-secondary Education Data System (IPEDS). http://nces.ed.gov/ipeds/.

National Center for Health Statistics. "Table 74. Healthy weight, overweight, and obesity among persons 20 years of age and over, by selected characteristics: United States, selected years 1960-1962 through 2007-2010" in *Health, United States, 2011 With Special Feature on Socioeconomic Status and Health.* Hyattsville, MD: National Center for Health Statistics, 2012.

National Survey on Drug Use and Health. "Table 1 (REVISED). Serious Mental Illness (SMI) in Past Year among Persons Aged 18 or Older, by location: Percentages, Annual Averages Based on 2008 and 2009 NSDUHs" in *The NSDUH Mental Illness: State Estimates of Adult Mental Illness. Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration, May 2012.*

National Survey on Drug Use and Health. "Table B.1 – Illicit Drug Use in the Past Month, by Age Group and State: Percentages, Annual Averages Based on 2009 and 2010 NSDUHs" in *State Estimates of Substance Use and Mental Disorders from the 2009-2010 National Surveys on Drug Use and Health.* NSDUH Series H-43, HHS Publication No. (SMA) 12-4703. Rockville, MD: Substance Abuse and Mental Health Services Administration, 2012.

North Carolina Department of Commerce. "2013 Impact of Visitor Spending." Accessed October 2014. http://www.nccommerce.com/LinkClick.aspx?fileticket=UgSNdkfheFw%3d&tabid=636&mid=4669

Office of Management and Budget. Circular A-94 Appendix C. Last modified December 2012. Accessed July 2013. http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c.

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

Polachek, Solomon W. "Earnings Over the Lifecycle: The Mincer Earnings Function and its Applications." *Foundations and Trends in Microeconomics* 4, no. 3 (2008): 165-272.

Polachek, Solomon W. "Mincer's Overtaking Point and the Lifecycle Earnings Distribution." *Review of the Economics of the Household* 1, no. 4 (December 2003): 273-304.

Ramey, Valerie and Neville Francis. "A Century of Work and Leisure." *American Economic Journal: Macroeconomics* 1, no.2 (2009): 189-224.

Sevilla, Almudena, Jose Ignacio Gimenez-Nadal, and Jonathan I. Gershuny. "Leisure Inequality in the United States: 1965-2003." IZA Discussion Paper no. 6708, July 2012.

Substance Abuse and Mental Health Services Administration. "Table 5.7B - Substance Dependence or Abuse in the Past Year among Persons Aged 26 or Older, by Demographic Characteristics: Percentages, 2010 and 2011." SAMSHA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2010 and 2011. Accessed August 2013. http://www.samhsa.gov/data/NSDUH/2011SummNatFindDetTables/NSDUH-DetTabsPDFWHTML2011/2k11DetailedTabs/Web/HTML/NSDUH-DetTabsSect5peTabs1to56-2011.htm.

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

Supplemental Nutrition Assistance Program. "State Activity Report Fiscal Year 2011." Food and Nutrition Service, Supplemental Nutrition Assistance Program, Program Accountability and Administration Division, December 2012. Accessed August 2013. http://www.fns.usda.gov/snap/qc/pdfs/2011_state_activity.pdf.

Truffer, Christopher J., Sean Keehan, Sheila Smith, Jonathan Cylus, Andrea Sisko, John Poisal, Joseph Lizonitz, and M. Kent Clemens. "Health Spending Projections Through 2019: The Recession's Impact Continues." *Health Affairs* 29, no. 3 (March 2010): 522-529.

U.S. Census Bureau. "Table 1. Educational Attainment of the Population 18 Years and Over, by Age, Sex, Race, and Hispanic Origin: 2012." Educational Attainment in the United States: 2012 - Detailed Tables. Accessed August 2013. http://www.census.gov/hhes/socdemo/education/data/cps/2012/tables.html.

U.S. Census Bureau. "Table 1363. Household Net Savings Rate by Country: 1995 to 2008" in "The 2012 Statistical Abstract International Statistics." Accessed June 2013. http://www.census.gov/compendia/statab/2012/tables/12s1363.pdf.

U.S. Census Bureau. "Social Insurance and Human Services" in "The 2012 Statistical Abstract." Accessed August 2013. http://www.census.gov/compendia/statab/cats/social_insurance_human_services.html.

U.S. Census Bureau. "State Characteristics: Vintage 2012." Population Estimates. Updated June 13, 2013. Accessed August 28, 2013. http://www.census.gov/popest/data/state/asrh/2012/index.html.

U.S. Department of Health and Human Services. "Chapter II. Indicators of Dependence" in "2008 Indicators of Welfare Dependence." Annual Report to Congress, 2008. Accessed August 2013. http://aspe.hhs.gov/hsp/indicators08/index.shtml.

U.S. Department of Health and Human Services, Office of Family Assistance. "Table 10:26 - Temporary Assistance for Needy Families - Active Cases: Percent Distribution of TANF Adult Recipients by Educational Level, FY 2009" in Temporary Assistance for Needy Families Program Ninth Report to Congress, 2012. Accessed August 2013. http://www.acf.hhs.gov/sites/default/files/ofa/ar9appendix.pdf.

U.S. Department of Labor. "Minimum Wage Laws in the States - January 1, 2013." U.S. Department of Labor Wage and Hour Division (WHD). Accessed May 2013. http://www.dol.gov/whd/minwage/america.htm.

U.S. Department of Labor. Unemployment Insurance Data Summary, 4th Quarter 2012. Accessed July 2013. http://www.ows.doleta.gov/unemploy/content/data.asp.

U.S. Department of the Treasury. "The Economic Costs of Smoking in the United States and the Benefits of Comprehensive Tobacco Legislation." Office of Public Affairs Report-3113, March 1998. Accessed August 2013. http://www.treasury.gov/press-center/press-releases/Documents/tobacco.pdf.

Walden, Michael, "The Local Economic Impact of the Cooperating Raleigh Colleges: Update 2013." March 2014, Accessed September 2014. http://crcraleighcolleges.org/files/crcimpact2013-final.pdf

Witters, Dan, Sengeeta Agrawal, and Diana Liu. "Depression Costs U.S. Workplaces $23 Billion in Absenteeism." Gallup-Healthways Well-Being Index, Gallup Wellbeing, July 24, 2013. Accessed August 28, 2013. http://www.gallup.com/poll/163619/depression-costs-workplaces-billion-absenteeism.aspx.

APPENDIX 1
THE UNC UNIVERSITIES

- Appalachian State University
- Elizabeth State University
- East Carolina University
- Fayetteville State University
- North Carolina A&T State University
- North Carolina Central University
- North Carolina State University
- University of North Carolina Asheville
- University of North Carolina Charlotte
- University of North Carolina Chapel Hill
- The University of North Carolina at Greensboro
- University of North Carolina at Pembroke
- University of North Carolina School of the Arts
- The University of North Carolina at Wilmington
- Western Carolina University
- Winston-Salem State University

APPENDIX 2
GLOSSARY OF TERMS

Alternative education A "with" and "without" measure of the percent of students who would still be able to avail themselves of education if the universities 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 universities in order to obtain their education.

Alternative use of funds A measure of how monies that are currently used to fund the universities might have otherwise been used if the universities did not exist.

Asset value Capitalized value of a stream of future returns. Asset value measures what someone would have to pay today for an instrument that provides the same stream of future revenues.

Attrition rate Rate at which students leave the workforce due to out-migration, unemployment, retirement, or death.

Benefit-cost ratio Present value of benefits divided by present value of costs. If the benefit-cost ratio is greater than 1, then benefits exceed costs, and the investment is feasible.

Credit hour equivalent A credit hour equivalent, or CHE, is defined as 15 contact hours of education if on a semester system, and 10 contact hours if on a quarter system. In general, it requires 450 contact hours to complete one full-time equivalent, or FTE.

Demand Relationship between the market price of education and the volume of education demanded (expressed in terms of enrollment). The law of the downward-sloping demand curve is related to the fact that enrollment increases only if the price (tuition and fees) is lowered, or conversely, enrollment decreases if price increases.

Discounting Expressing future revenues and costs in present value terms.

Economics Study of the allocation of scarce resources among alternative and competing ends. Economics is not normative (what ought to be done), but positive (describes what is, or how people are likely to behave in response to economic changes).

Elasticity of demand Degree of responsiveness of the quantity of education demanded (enrollment) to changes in market prices (tuition and fees). If a decrease in fees increases total revenues, demand is elastic. If it decreases total revenues, demand is inelastic. If total revenues remain the same, elasticity of demand is unitary.

Externalities Impacts (positive and negative) for which there is no compensation. Positive externalities of education include improved social behaviors such as lower crime, reduced welfare and unemployment, and improved health. Educational institutions do not receive compensation for these benefits, but benefits

still occur because education is statistically proven to lead to improved social behaviors.

Gross state product Measure of the final value of all goods and services produced in a state after netting out the cost of goods used in production. Alternatively, gross state product (GSP) equals the combined incomes of all factors of production; i.e., labor, land and capital. These include wages, salaries, proprietors' incomes, profits, rents, and other. Gross state product is also sometimes called value added or income.

Initial effect Income generated by the initial injection of monies into the economy through the payroll of the universities and the higher earnings of their students.

Input-output analysis Relationship between a given set of demands for final goods and services and the implied amounts of manufactured inputs, raw materials, and labor that this requires. In an educational setting, when universities pay wages and salaries and spend money for supplies in the state, 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.

Labor income Income that is received as a result of labor; i.e., wages.

Multiplier effect Additional income created in the economy as the universities and their students spend money in the state. It consists of the income created by the supply chain of the industries initially affected by the spending of the universities and their students (i.e., the direct effect), income created by the supply chain of the initial supply chain (i.e., the indirect effect), and the income created by the increased spending of the household sector (i.e., the induced effect).

Net cash flow Benefits minus costs, i.e., the sum of revenues accruing from an investment minus costs incurred.

Net present value Net cash flow discounted to the present. All future cash flows are collapsed into one number, which, if positive, indicates feasibility. The result is expressed as a monetary measure.

Non-labor income Income received from investments, such as rent, interest, and dividends.

Opportunity cost Benefits forgone from alternative B once a decision is made to allocate resources to alternative A. Or, if individuals choose to attend college, they forgo earnings that they would have received had they chosen instead to work full-time. Forgone earnings, therefore, are the "price tag" of choosing to attend college.

Payback period Length of time required to recover an investment. The shorter the period, the more attractive the investment. The formula for computing payback period is:

Payback period =
cost of investment/net return per period

APPENDIX 3
EMSI MR-SAM

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

This appendix presents a high-level overview of the MR-SAM. Additional documentation on the technical aspects of the model is available upon request.

A2.1 DATA SOURCES FOR THE MODEL

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

- **EMSI Data** are produced from many data sources to produce detailed industry, occupation, and demographic jobs and earnings data at the local level. This information (especially sales-to-jobs ratios derived from jobs and earnings-to-sales ratios) is used to help regionalize the national matrices as well as to disaggregate them into more detailed industries than are normally available.
- **BEA Make and Use Tables** (MUT) are the basis for input-output models in the U.S. The *make* table is a matrix that describes the amount of each commodity made by each industry in a given year. Industries are placed in the rows and commodities in the columns. The *use* table is a matrix that describes the amount of each commodity used by each industry in a given year. In the use table, commodities are placed in the rows and industries in the columns. The BEA produces two different sets of MUTs, the benchmark and the summary. The benchmark set contains about 500 sectors and is released every five years, with a five-year lag time (e.g., 2002 benchmark MUTs were released in 2007). The summary set contains about 80 sectors and is released every year,

with a two-year lag (e.g., 2010 summary MUTs were released in late 2011/early 2012). The MUTs are used in the EMSI SAM model to produce an industry-by-industry matrix describing all industry purchases from all industries.

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

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

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

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

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

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

- **Census' Current Population Survey** (CPS) is used as the basis for the demographic breakout data of the MR-SAM model. This set is used to estimate the

ratios of demographic cohorts and their income for the three different income categories (i.e., wages, property income, and transfers).

- **Census' Journey-to-Work** (JtW) is part of the 2000 Census and describes the amount of commuting jobs between counties. This set is used to fill in the areas where OTM does not have data.
- **Census' American Community Survey** (ACS) **Public Use Microdata Sample** (PUMS) is the replacement for Census' long form and is used by EMSI to fill the holes in the CPS data.
- **Oak Ridge National Lab (ORNL) County-to-County Distance Matrix** (Skim Tree) contains a matrix of distances and network impedances between each county via various modes of transportation such as highway, railroad, water, and combined highway-rail. Also included in this set are minimum impedances utilizing the best combination of paths. The ORNL distance matrix is used in EMSI's gravitational flows model that estimates the amount of trade between counties in the country.

A2.2 OVERVIEW OF THE MR-SAM MODEL

EMSI'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 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).

A2.2.1 National SAM

Following standard practice, the SAM model appears as a square matrix, with each row sum exactly equaling the corresponding column sum. Reflecting its kinship with the standard Leontief input-output framework, individual SAM elements show accounting flows between row and column sectors during a chosen base year. Read across rows, SAM entries show the flow of funds into column accounts (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 1,100 detailed accounts.

A2.2.2 Multi-regional aspect of the SAM

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

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

A2.3 COMPONENTS OF THE EMSI MR-SAM MODEL

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

A2.3.1 County earnings distribution matrix

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

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

A2.3.2 Commuting model

The commuting sub-model is an integral part of EMSI's MR-SAM model. It allows the regional and multi-regional models to know what amount of the earnings can be attributed to place-of-residence vs. place-of-work. The commuting data describe the flow of earnings from any county to any other county (including within the counties themselves). For this situation, the commuted earnings are not just a single value describing total earnings flows over a complete year, but are broken out by occupation and demographic. Breaking out the earnings allows for analysis of place-of-residence and place-of-work earnings. These

data are created using BLS' OnTheMap dataset, Census' Journey-to-Work, BEA's LPI CA91 and CA05 tables, and some of EMSI's data. The process incorporates the cleanup and disaggregation of the OnTheMap data, the estimation of a closed system of county inflows and outflows of earnings, and the creation of finalized commuting data.

A2.3.3 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 uses a modification of the "diagonal similarity scaling" algorithm to balance the national SAM.

A2.3.4 Gravitational flows model

The most important piece of the EMSI 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 4
EXTENSION SPENDING IMPACTS
NORTH CAROLINA'S EIGHT PROSPERITY ZONES

These impacts are not in addition to the statewide impacts estimated above. They are estimated relative to specific regions and are standalone impacts. Because these impacts are estimated for different regions, they should not be summed or added to other impacts in this study, as they are estimated at the state level.

TABLE A4.1: EXTENSION SERVICES SPENDING IMPACT – NORTHEAST PROSPERITY ZONE

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS)	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$9,436**		**$0**		**$9,436**		**100**
MULTIPLIER EFFECT							
Direct effect	$151		$310		$461		6
Indirect effect	$14		$28		$43		1
Induced effect	$1,097		$1,592		$2,688		38
Total multiplier effect	$1,262		$1,930		$3,192		45
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$10,698**		**$1,930**		**$12,628**		**145**

Source: EMSI impact model.

TABLE A4.2: EXTENSION SERVICES SPENDING IMPACT – SOUTHEAST PROSPERITY ZONE

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS)	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$8,990**		**$0**		**$8,990**		**104**
MULTIPLIER EFFECT							
Direct effect	$206		$438		$644		7
Indirect effect	$27		$50		$76		1
Induced effect	$1,358		$1,893		$3,251		47
Total multiplier effect	$1,591		$2,380		$3,971		55
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$10,581**		**$2,380**		**$12,961**		**159**

Source: EMSI impact model.

TABLE A4.3: EXTENSION SERVICES SPENDING IMPACT – NORTH CENTRAL PROSPERITY ZONE

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS)	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$11,255**		**$0**		**$11,255**		**160**
MULTIPLIER EFFECT							
Direct effect	$389		$628		$1,017		10
Indirect effect	$83		$102		$186		2
Induced effect	$2,910		$3,028		$5,938		77
Total multiplier effect	$3,382		$3,759		$7,141		89
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$14,637**		**$3,759**		**$18,395**		**249**

Source: EMSI impact model.

TABLE A4.4: EXTENSION SERVICES SPENDING IMPACT – SANDHILLS PROSPERITY ZONE

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS)	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$6,540**		**$0**		**$6,540**		**86**
MULTIPLIER EFFECT							
Direct effect	$94		$179		$274		3
Indirect effect	$7		$12		$19		<1
Induced effect	$753		$941		$1,694		26
Total multiplier effect	$855		$1,132		$1,987		29
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$7,395**		**$1,132**		**$8,527**		**115**

Source: EMSI impact model.

TABLE A4.5: EXTENSION SERVICES SPENDING IMPACT – PIEDMONT-TRIAD PROSPERITY ZONE

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS)	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$6,710**		**$0**		**$6,710**		**84**
MULTIPLIER EFFECT							
Direct effect	$168		$303		$471		5
Indirect effect	$31		$45		$76		1
Induced effect	$1,425		$1,579		$3,004		40
Total multiplier effect	$1,624		$1,928		$3,552		46
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$8,334**		**$1,928**		**$10,262**		**130**

Source: EMSI impact model.

TABLE A4.6: EXTENSION SERVICES SPENDING IMPACT – SOUTHWEST PROSPERITY ZONE

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS)	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$6,033**		**$0**		**$6,033**		**79**
MULTIPLIER EFFECT							
Direct effect	$190		$361		$551		5
Indirect effect	$45		$71		$116		1
Induced effect	$1,495		$1,666		$3,161		40
Total multiplier effect	$1,730		$2,098		$3,828		45
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$7,763**		**$2,098**		**$9,861**		**124**

Source: EMSI impact model.

TABLE A4.7: EXTENSION SERVICES SPENDING IMPACT – NORTHWEST PROSPERITY ZONE

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS)	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$6,720**		**$0**		**$6,720**		**68**
MULTIPLIER EFFECT							
Direct effect	$111		$227		$339		5
Indirect effect	$10		$16		$26		<1
Induced effect	$838		$1,154		$1,993		29
Total multiplier effect	$959		$1,398		$2,357		34
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$7,679**		**$1,398**		**$9,077**		**102**

Source: EMSI impact model.

TABLE A4.8: EXTENSION SERVICES SPENDING IMPACT – WESTERN PROSPERITY ZONE

	LABOR INCOME (THOUSANDS)	+	NON-LABOR INCOME (THOUSANDS)	=	TOTAL ADDED INCOME (THOUSANDS)	OR	JOB EQUIVALENTS
INITIAL EFFECT	**$7,955**		**$0**		**$7,955**		**84**
MULTIPLIER EFFECT							
Direct effect	$133		$272		$405		6
Indirect effect	$11		$20		$31		<1
Induced effect	$992		$1,367		$2,360		34
Total multiplier effect	$1,137		$1,659		$2,795		41
TOTAL IMPACT (INITIAL + MULTIPLIER)	**$9,091**		**$1,659**		**$10,750**		**125**

Source: EMSI impact model.

APPENDIX 5
VALUE PER CREDIT HOUR EQUIVALENT & 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.

A3.1 VALUE PER CHE

Typically the educational achievements of students are marked by the credentials they earn. However, not all students who attended UNC universities in the 2012-13 analysis year obtained a degree or certificate. Some returned the following year to complete their education goals, while others took a few courses and entered the workforce without graduating. As such, the only way to measure the value of the students' achievement is through their credit hour equivalents, or CHEs. This approach allows us to see the benefits to all students who attended the universities, not just those who earned a credential.

To calculate the value per CHE, we first determine how many CHEs are required to complete each education level. For example, assuming that there are 30 CHEs in an academic year, a student generally completes 60 CHEs in order to move from a high school diploma to an associate's degree, another 60 CHEs to move from an associate's degree to a bachelor's degree, and so on. This progression of CHEs generates an education ladder beginning at the less than high school level and ending with the completion of a doctoral degree, with each level 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 presented in Table 1.7. For example, the difference in earnings between a high school diploma and an associate's degree is $10,800. We spread this $10,800 wage differential across the 60 CHEs that occur between the high school diploma and the associate's degree, applying a ceremonial "boost" to the last CHE in the stage to mark the achievement of the degree.[40] We repeat this process for each education level in the ladder.

Next we map the CHE production of the 2012-13 student population to the education

40 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 college impact model are derived from Jaeger and Page (1996).

ladder. Table 1.4 provides information on the CHE production of students attending UNC universities, broken out by educational achievement. In total, students completed 6.7 million CHEs during the analysis year, excluding the CHE production of personal enrichment students. We map each of these CHEs to the education ladder depending on the students' education level and the average number of CHEs they completed during the year. For example, bachelor's degree graduates are allocated to the stage between the associate's 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:

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

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 A3.1 displays the result for the students' aggregate annual increase in income (ΔE), a total of $1.3 billion. By dividing this value by the students' total production of 6.7 million CHEs during the analysis year, we derive an overall value of $193 per CHE.

A3.2 MINCER FUNCTION

The $193 value per CHE in Table A3.1 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.[41] 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 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 United States based Mincer coefficients estimated by Polachek (2003).

Figure A3.1 illustrates several important points about the Mincer function. First, as

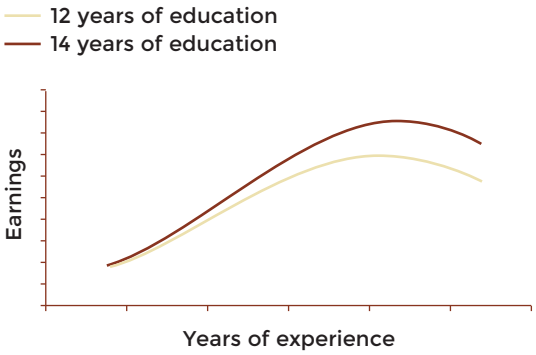
TABLE A3.1: AGGREGATE ANNUAL INCREASE IN INCOME OF STUDENTS AND VALUE PER CHE

Aggregate annual increase in income	$1,295,004,673
Total credit hour equivalents (CHEs) in FY 2012-13*	6,696,841
Value per CHE	**$193**

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

41 See Mincer (1958 and 1974).

FIGURE A3.1: LIFECYCLE CHANGE IN EARNINGS, 12 YEARS VERSUS 14 YEARS OF EDUCATION



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.

In calculating the alumni impact in Section 2, we use the slope of the curve in Mincer's earnings function to condition the $193 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 $193 value per CHE applies only to the CHE production of students precisely at the midpoint of their careers during the analysis year.

In Section 3 we again apply the Mincer function, this time to project the benefits stream of the 2012-13 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 A5.1.

APPENDIX 6
ALTERNATIVE EDUCATION VARIABLE

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

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

In the absence of UNC universities, we assume 15% of students attending UNC universities would find alternative education opportunities and remain in or return to North Carolina. We account for this by discounting the alumni impact, the benefits to taxpayers, and the benefits to society in North Carolina in Sections 3 and 4 by 15%. In other words, we assume 15% of the benefits created by students attending UNC universities would have occurred anyways in the counterfactual scenario where UNC universities do not exist. A sensitivity analysis of this adjustment is presented in Section 4.

APPENDIX 7
OVERVIEW OF INVESTMENT ANALYSIS MEASURES

The purpose of this appendix is to provide context to the investment analysis results using the simple hypothetical example summarized in Table A5.1 below. The table shows the projected benefits and costs for a single student over time and associated investment analysis results.[42]

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

TABLE A5.1: 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
Internal rate of return					18.0%
Benefit-cost ratio					1.7
Payback period					4.2 years

Assumptions are as follows:

- Benefits and costs are projected out 10 years into the future (Column 1).
- The student attends one of the universities for one year, and the cost of tuition is $1,500 (Column 2).
- Earnings forgone while attending one of the universities for one year (opportunity cost) come to $20,000 (Column 3).
- Together, tuition and earnings forgone cost sum to $21,500. This represents the out-of-pocket investment made by the student (Column 4).
- In return, the student earns $5,000 more per year than he would have otherwise 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 A7.1.

A5.1 NET PRESENT VALUE

The student in Table A5.1 can choose either to attend one of the universities or to forgo post-secondary education and maintain his present employment. If he decides to enroll, certain economic implications unfold. Tuition and fees must be paid, and earnings will cease for one year. In exchange, the student calculates that with post-secondary education, his income will increase by at least the $5,000 per year, as indicated in the table.

The question is simple: Will the prospective student be economically better off by choosing to enroll? If he adds up higher earnings of $5,000 per year for the remaining nine years in Table A7.1, the total will be $45,000. Compared to a total investment of $21,500, this appears to be a very solid investment. The reality, however, is different. Benefits are far lower than $45,000 because future money is worth less than present money. Costs (tuition plus earnings forgone) are felt immediately because they are incurred today, in the present. Benefits, on the other hand, occur in the future. They are not yet available. All future benefits must be discounted by the going rate of interest (referred to as the discount rate) to be able to express them in present value terms.[43]

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

43 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.

earnings – allows the model to express values on an equal basis in future or present value terms.

The goal is to express all future higher earnings in present value terms so that they can be compared to investments incurred today (in this example, tuition plus earnings forgone). As indicated in Table A5.1, 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.

A5.2 INTERNAL RATE OF RETURN

The internal rate of return is another way of measuring the worth of investing in education using the same cash flows shown in Table A5.1. 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 A7.1. 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 incomes of $5,000 per year for the next nine years will earn back all investments of $21,500 made plus pay 18.0% for the use of that money ($21,500) in the meantime. Is this a good return? Indeed it is. If it is compared to the 4% going rate of interest applied to the net present value calculations, 18.0% is far higher than 4%. It may be concluded, therefore, that the investment in this case is solid. Alternatively, comparing the 18.0% rate of return to the long-term 7% rate or so obtained from investments in stocks and bonds also indicates that the investment in education is strong relative to the stock market returns (on average).

A5.3 BENEFIT-COST RATIO

The benefit-cost ratio is simply the present value of benefits divided by present value of costs, or $35,753 ÷ $21,500 = 1.7 (based on the 4% 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.

A5.4 PAYBACK PERIOD

This is the length of time from the beginning of the investment (consisting of tuition and earnings forgone) until higher future earnings give a return on the investment made. For the student in Table A5.1, it will take roughly 4.2 years of $5,000 worth of higher earnings to recapture his investment of $1,500 in tuition and the $20,000 in earnings forgone while attending the universities. 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 8
SOCIETAL EXTERNALITIES

Education has a predictable and positive effect on a diverse array of societal benefits. These, when quantified in dollar terms, represent significant social savings that directly benefit society communities and citizens throughout North Carolina, including taxpayers. In this appendix we discuss the following three main benefit categories: 1) improved health, 2) reductions in crime, and 3) reductions in welfare and unemployment.

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

A6.1 HEALTH

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

A6.1.1 Smoking

Despite a marked decline over the last several decades in the percentage of U.S. residents that smoke, a sizeable percentage of the U.S. population still uses tobacco. The negative health effects of smoking are well documented in the literature, which identifies smoking as one of the most serious health issues in the U.S.

Figure A6.1 on the next page shows the prevalence of cigarette smoking among adults aged 25 years and over, based on data provided by the National Health Interview Survey.[44] As indicated, the percent of persons who smoke begins to decline beyond the level of high school education.

The Centers for Disease Control and Prevention (CDC) reports the percentage of adults who are current smokers by state.[45] We use this information to create an index value by which we adjust the national prevalence data

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

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

FIGURE A6.1: PREVALENCE OF SMOKING AMONG U.S. ADULTS BY EDUCATION LEVEL

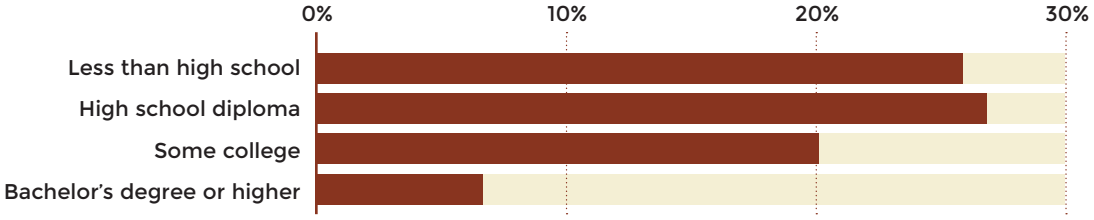
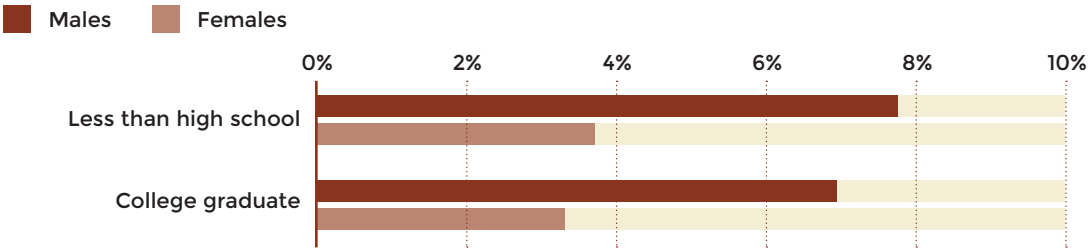


FIGURE A6.2: PREVALENCE OF ALCOHOL DEPENDENCE OR ABUSE BY SEX AND EDUCATION LEVEL



on smoking to each state. For example, 21.8% of North Carolina' adults were smokers in 2011, relative to 21.2% for the nation. We thus apply a scalar of 1.0 to the national probabilities of smoking in order to adjust them to the state of North Carolina.

A6.1.2 Alcohol abuse

Alcoholism is difficult to measure and define. There are many patterns of drinking, ranging from abstinence to heavy drinking. Alcohol abuse is riddled with societal costs, including healthcare expenditures for treatment, prevention, and support; workplace losses due to reduced worker productivity; and other effects.

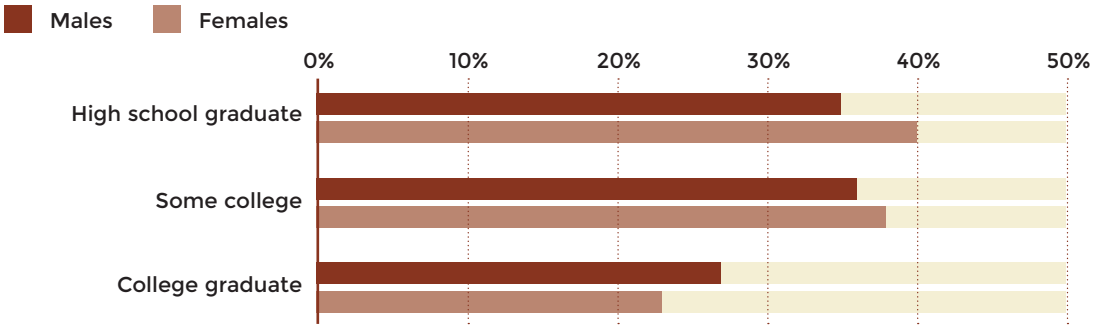
Figure A6.2 compares the percent of males and females aged 26 and older that abuse or depend on alcohol at the less than high school level to the prevalence rate of alcoholism among college graduates, based on data supplied by the Substance Abuse and Mental Health Services Administration (SAMHSA).[46] These statistics give an indication of the correlation between education and the reduced probability of alcoholism. As indicated, alcohol dependence or abuse falls from a 7.7% prevalence rate among males with less than a high school diploma to a 6.9% prevalence rate among males with a college degree. Similarly, alcohol dependence or abuse among females ranges from a 3.7% prevalence rate at the less than high school level to a 3.3% prevalence rate at the college graduate level.

A6.1.3 Obesity

The rise in obesity and diet-related chronic diseases has led to increased attention on how

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

FIGURE A6.3: PREVALENCE OF OBESITY BY EDUCATION LEVEL



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.[47] The CDC also reports the prevalence of obesity among adults by state.[48]

Data for Figure A6.3 was provided by the National Center for Health Statistics which shows the prevalence of obesity among adults aged 20 years and over by education and sex.[49] As indicated, college graduates are less likely to be obese than individuals with a high school diploma. However, the prevalence of obesity among males with some college is actually greater than males with no more than a high school diploma. In general, though, obesity tends to decline with increasing levels of education.

A6.1.4 Mental illness

Capturing the full economic cost of mental disorders is problematic because many of the costs are hidden or difficult to detach from others externalities, such as drug abuse or alcoholism. For this reason, this study only examines the costs of absenteeism caused by depression in the workplace. Figure A6.4 on the next page summarizes the prevalence of self-reported frequent mental distress among adults by education level, based on data supplied by the CDC.[50] As shown, people with higher levels of education are less likely to suffer from mental illness, with the prevalence of mental illness being the highest among people with less than a high school diploma.

A6.1.5 Drug abuse

The burden and cost of illicit drug abuse is enormous in our society, but little is known

47 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.

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

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

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

FIGURE A6.4: PREVALENCE OF FREQUENT MENTAL DISTRESS BY EDUCATION LEVEL

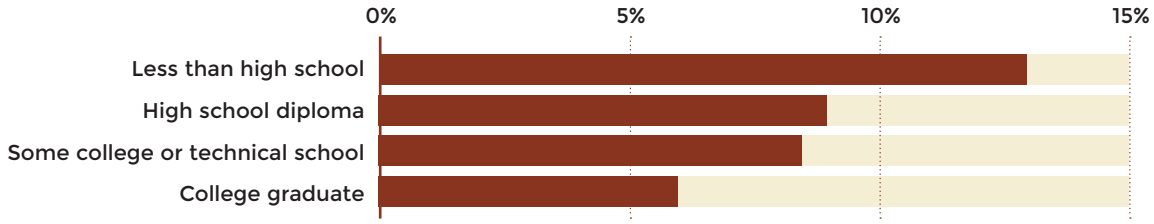
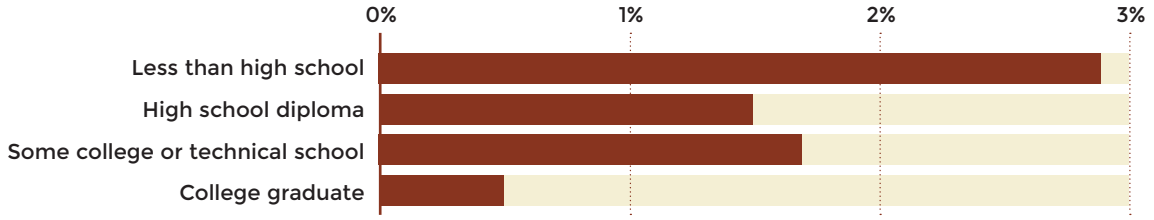


FIGURE A6.5: PREVALENCE OF ILLICIT DRUG DEPENDENCE OR ABUSE BY EDUCATION LEVEL



about potential costs and effects at a population level. What is known is that the rate of people abusing drugs is inversely proportional to their education level. The higher the education level, the less likely a person is to abuse or depend on illicit drugs. The probability that a person with less than a high school diploma will abuse drugs is 2.9%, nearly six times greater than the probability of drug abuse for college graduates (0.5%). This relationship is presented in Figure A6.5 based on data supplied by SAMHSA.[51] Health costs associated with illegal drug use are also available from SAMSHA, with costs to state and local government representing 48% of the total cost related to illegal drug use.[52]

A6.2 CRIME

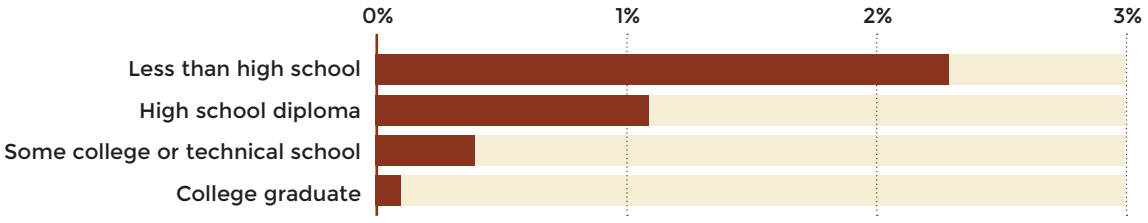
As people achieve higher education levels, they are statistically less likely to commit crimes. The analysis identifies the following three types of crime-related expenses: 1) criminal justice expenditures, including police protection, judicial and legal, and corrections, 2) victim costs, and 3) productivity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

Figure A6.6 displays the probability that an individual will be incarcerated by education level. Data are derived from the breakdown of the inmate population by education level in federal, state, and local prisons as provided by

51 Substance Abuse and Mental Health Services Administration, National Survey on Drug Use and Health, 2010 and 2011.

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

FIGURE A6.6: INCARCERATION RATES BY EDUCATION LEVEL



the Bureau of Justice Statistics,[53] divided by the total adult population. As indicated, incarceration drops on a sliding scale as education levels rise.

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 (McCollister et al., 2010).

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

A6.3 WELFARE & UNEMPLOYMENT

Statistics show that as education levels increase, the number of welfare and unemployment applicants declines. Welfare and unemployment claimants can receive assistance from a variety of different sources, including Temporary Assistance for Needy Families (TANF), Supplemental Nutrition Assistance Program (SNAP), Medicaid, Supplemental Security Income (SSI), and unemployment insurance.[54]

FIGURE A6.7: BREAKDOWN OF TANF RECIPIENTS BY EDUCATION LEVEL

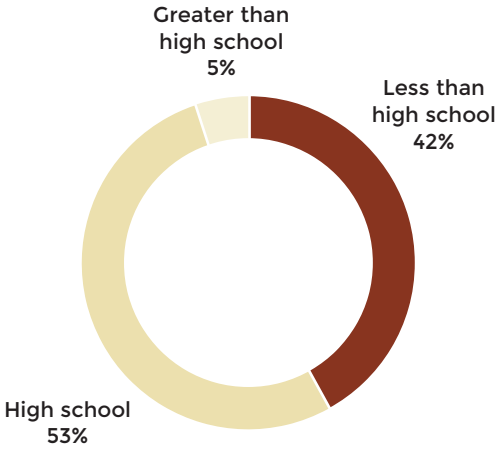


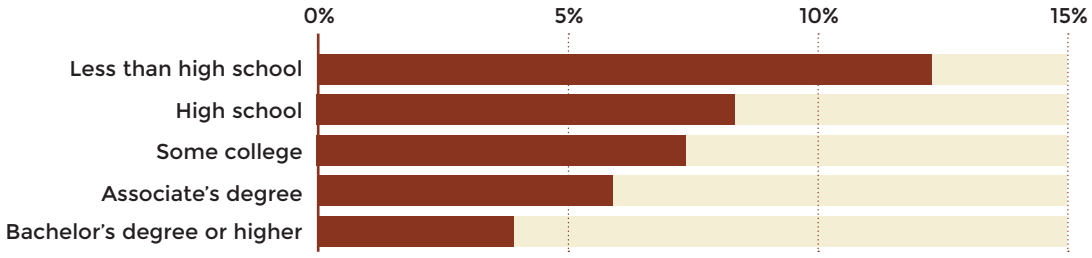
Figure A6.7 relates the breakdown of TANF recipients by education level, derived from data supplied by the U.S. Department of Health and Human Services.[55] As shown, the demographic

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

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

55 U.S. Department of Health and Human Services, Office of Family Assistance, "Table 10:26 - Temporary Assistance for Needy Families - Active Cases: Percent Distribution

FIGURE A6.8: UNEMPLOYMENT BY EDUCATION LEVEL



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 A6.8. These data are supplied by the Bureau of Labor Statistics.[56] As shown, unemployment rates range from 12.4% for those with less than a high school diploma to 4.0% for those at the bachelor's degree level or higher.

of TANF Adult Recipients by Educational Level, FY 2009" in Temporary Assistance for Needy Families Program Ninth Report to Congress, 2012.

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