VCU

Main Report

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The Economic Value of Virginia Commonwealth University to Virginia

Reflects FY 2023-24

Lightcast

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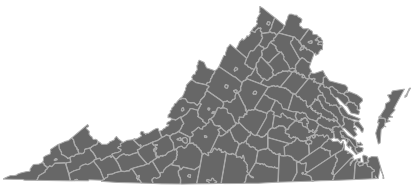
Executive summary

This report assesses the impact of Virginia Commonwealth University (VCU)[1] on the economy of Virginia and the benefits generated by VCU for students, taxpayers, and society. The results of this study show that VCU creates a positive net impact on the state economy and generates a positive return for students, taxpayers, and society.

1 The VCU Health System Authority, serving the clinical functions of VCU, and Virginia Commonwealth University, fulfilling the academic and research missions of VCU, are closely affiliated partners. Together the two will be referred to as "Virginia Commonwealth University" or "VCU" in this report. The VCU Health System Authority, will be referred to as "VCU Health System" or "Health System." The academic and research enterprise will be referred to as "the university."

Economic impact analysis

During the analysis year, VCU spent $2.6 billion on payroll and benefits for 23,107 full-time and part-time employees and spent another $1.9 billion on goods and services to carry out its day-to-day university operations, construction, VCU Health System operations, and research activities. The initial round of spending creates more spending across other businesses throughout the economy of Virginia, resulting in the commonly referred to multiplier effects. The economic impact analysis estimates the net economic impact of VCU that directly accounts for the fact that money from Virginia and local dollars spent on VCU could have been spent elsewhere in the state if not directed toward VCU 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 VCU.



Virginia

The additional income of **$9.2 billion** created by VCU is equal to approximately **1.4%** of the total gross state product of Virginia.

The economic impact analysis shows that in fiscal year (FY) 2023-24, university operations, construction, VCU Health System operations, research, entrepreneurial, visitor, and student spending of VCU, together with university employee volunteerism and the enhanced productivity of the university's alumni, generated **$9.2 billion in added income** for the Virginia economy. The additional income of $9.2 billion created by VCU is equal to approximately **1.4%** of the total gross state product (GSP) of Virginia. For perspective, this impact from VCU is larger than the entire Arts, Entertainment, & Recreation industry in Virginia. The impact of $9.2 billion in added income is equivalent to **$18.5 billion in sales** and to supporting **95,707 jobs**. For further perspective, this means that **one out of every 61 jobs**

in Virginia is supported by the activities of VCU and its students. These economic impacts break down as follows:

VCU spending impact

In FY 2023-24, VCU employed 23,107 full-time and part-time employees across its academic and VCU Health System enterprises. VCU spent $2.6 billion on payroll to its employees, along with another $1.9 billion on non-payroll related expenditures. The combination of VCU's operations, construction, health system, and research spending, detailed more fully below, generated a total of **$4.9 billion in added income** to the economy of Virgina, equivalent to **$8.6 billion in sales** and to supporting **46,992 jobs**.

University operations spending impact[2]

Payroll and benefits to support the university's day-to-day operations amounted to $525.0 million. The university's non-pay expenditures amounted to $354.3 million. The net impact of operations spending by the university in Virginia during the analysis year was approximately **$463.8 million in added income**, which is equivalent to **$777.9 million in sales** and to supporting **4,718 jobs**.

University construction spending impact

The university invests in capital projects each year to maintain its facilities, create additional capacities, and meet its 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 2023-24, the university's construction spending generated **$20.7 million in added income**, which is equivalent to **$82.7 million in sales** and to supporting **213 jobs**.

Health system spending impact

In FY 2023-24, the VCU Health System spent $3.1 billion on faculty and staff payroll and other expenditures to support its operations. The total net impact of these health system operations in Virginia was **$4.0 billion in added income**, which is equivalent to **$7.1 billion in sales** and to supporting **37,819 jobs**.

University research spending impact

Research activities of the university impact the state economy by employing people and making purchases for equipment, supplies, and services. They also facilitate new knowledge creation throughout Virginia. In FY 2023-24, the university spent $286.6 million on payroll and $123.0 million on other expenditures to support research activities (excluding indirect costs). Research spending of the university generated

2 Research and VCU Health System employees and their payroll, as well as non-pay expenses for research, VCU Health System, and construction, are excluded from the university operations spending impact as they are measured in the following impacts.

$416.3 million in added income for the Virginia economy, which is equivalent to **$620.6 million in sales** and to supporting **4,242 jobs**.

Start-up and spin-off company impact

The university creates an environment that fosters innovation and entrepreneurship, evidenced by the number of start-up and spin-off companies related to the university in the state. In FY 2023-24, start-up and spin-off companies related to the university added **$37.1 million in income** for the Virginia economy, which is equivalent to **$62.9 million in sales** and to supporting **223 jobs**.

Visitor spending impact

Out-of-state visitors attracted to Virginia for activities at the university brought new dollars to the economy through their spending at hotels, restaurants, gas stations, and other businesses in the state. The spending from these visitors added approximately **$5.4 million in income** for the Virginia economy, which is equivalent to **$17.4 million in sales** and to supporting **128 jobs**.

Student spending impact

Around 13% of all students attending the university originated from outside the state. Some of these students relocated to Virginia to attend the university. In addition, some students, referred to as retained students, are residents of Virginia who would have left the state if not for the existence of the university. The money that these students spent toward living expenses in Virginia is attributable to the university.

The expenditures of relocated and retained students in the state during the analysis year added approximately **$151.7 million in income** for the Virginia economy, which is equivalent to **$447.8 million in sales** and to supporting **2,629 jobs**.

University employee volunteerism impact

The university encourages its employees to volunteer in Virginia, where they can work with businesses and organizations to help meet their goals. The known volunteer hours of these employee volunteers allows businesses and organizations to grow, increasing their output and impacting the economy at large. University employees volunteered more than 12,700 hours of their time in Virginia in FY 2023-24. The known volunteer hours of university employee volunteers is equivalent to $432.4 thousand in earnings.

In terms of actual impact to the Virginia economy, the known volunteer hours of university employee volunteers generated an impact of **$599.8 thousand in added income** for the state in FY 2023-24, equivalent to **$1.1 million in sales** and to supporting **17 jobs**.

Alumni impact

Over the years, students gained new skills, making them more productive workers, by studying at the university. Today, thousands of these former students are employed in Virginia.

The accumulated impact of former students currently employed in the Virginia workforce amounted to **$4.1 billion in added income** for the Virginia economy, which is equivalent to **$9.4 billion in sales** and to supporting **45,718 jobs**.

Economic impact analyses use different types of impacts to estimate the results.

- The **added income impact** focuses on the change in income in the state. It excludes money that leaked out of the Virgina economy to out-of-state suppliers and excludes intermediary transactions. Added income is also synonymous with gross state product.
- The **sales impact** comprises the change in business sales revenue in the economy as a result of increased economic activity. It is synonymous with output. It is important to bear in mind that some of this sales revenue leaves the state economy through intermediary transactions and costs.
- The **jobs supported impact** is a measure of the number of full- and part-time jobs that would be required to support the change in income or sales.

Investment analysis

Investment analysis is the practice of comparing the costs and benefits of an investment to determine whether it is profitable. This study evaluates VCU as an investment from the perspectives of students, taxpayers, and society.

Student perspective

Students invest their own money and time in their education to pay for tuition, books, and supplies. Many take out student loans to attend the university, which they will pay back over time. While some students were employed while attending the university, students overall forewent earnings that they would have generated had they been in full employment instead of learning. Summing these direct outlays, opportunity costs, and future student loan costs yields a total of **$571.3 million** in present value student costs.

In return, students will receive a present value of **$3.6 billion** in increased earnings over their working lives. This translates to a return of **$6.30** in higher future earnings for every dollar that students invest in their education at the university. The corresponding annual rate of return is **22.0%**.

Taxpayer perspective

Taxpayers provided **$615.7 million** of funding to VCU in FY 2023-24 from the government of Virginia and local government. In return, taxpayers will receive an estimated present value of **$1.1 billion**

For every tax dollar spent, taxpayers will receive an average of **$2.00** in return over the course of the students' working lives.

in added tax revenue stemming from the students' higher lifetime earnings and the increased output of businesses. Savings to the public sector add another estimated **$129.8 million** in benefits due to a reduced demand for government-funded social services in Virginia. Total taxpayer benefits amount to **$1.2 billion**, the present value sum of the added tax revenue and public sector savings. For every tax dollar spent, taxpayers will receive an average of **$2.00** in return over the course of the students' working lives. In other words, taxpayers receive an annual rate of return of **11.5%**.

Social perspective

Citizens in Virginia invested **$1.6 billion** in VCU in FY 2023-24. This includes VCU's expenditures, student expenses, and student opportunity costs. In return, the Commonwealth of Virginia will receive an estimated present value of **$12.3 billion** in added revenue over the course of the students' working lives. Virginia will also benefit from an estimated **$685.1 million** in present value social savings associated with a more educated populace, leading to reduced crime, lower welfare and unemployment assistance, and increased health and well-being across the Commonwealth. For every dollar society invests in VCU, an average of **$7.90** in benefits will accrue to Virginia over the course of the students' careers.

Acknowledgments

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Chapter 1:

Introduction

VIRGINIA COMMONWEALTH UNIVERSITY (VCU),[3] established in 1838, has today grown to serve 31,414 students.[4] The university is led by President Michael Rao, Ph.D. The university's service region, for the purpose of this report, is Virginia.

While this study only considers the economic benefits generated by VCU, it is worth noting the state receives a variety of benefits from VCU, including social and cultural benefits that are difficult to quantify. The university naturally helps students achieve their individual potential and develop the knowledge, skills, and abilities they need to have fulfilling and prosperous careers. VCU, as an R1 research university with a top-ranked health system, impacts Virginia beyond influencing the lives of students. The university supplies employers with an educated workforce, making businesses more productive. Further, the state economy is supported through the increased output and employment generated by state vendors as the result of the activities of VCU, the university's day-to-day and construction operations, VCU Health System's operations, the university's research, entrepreneurial activities, the expenditures of university visitors and students, and the university's employee volunteers The benefits created by VCU extend as far as the treasury of Virginia in terms of the increased tax receipts and decreased public sector costs generated by students across the Commonwealth.

VCU, as an R1 research university with a top-ranked health system, impacts Virginia beyond influencing the lives of students.

This report assesses the impact of VCU as a whole on the state economy and the benefits generated by VCU for students, taxpayers, and society. The approach is twofold. We begin with an economic impact analysis of VCU on the Virginia economy. To derive results, we rely on a specialized Multi-Regional Social Accounting Matrix (MR-SAM) model to calculate the added income created in the Virginia 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 the university's operations spending, 2) impact of the university's construction

3 The VCU Health System Authority, serving the clinical functions of VCU, and Virginia Commonwealth University, fulfilling the academic and research missions of VCU, are closely affiliated partners. Together the two will be referred to as "Virginia Commonwealth University" or "VCU" in this report. The VCU Health System Authority, will be referred to as "VCU Health System" or "Health System." The academic and research enterprise will be referred to as "the university."

4 These numbers represent unduplicated student headcounts across the academic year and may differ from other student headcount reporting using Census 2 headcounts.

spending, 3) impact of VCU's Health System spending, 4) impact of the university's research spending, 5) impact of entrepreneurial activities, 6) impact of visitor spending, 7) impact of student spending, 8) impact of the university's employee volunteers, and 9) impact of alumni who are still employed in the Virginia workforce.

The second component of the study measures the benefits generated by VCU 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, the cost of interest incurred on student loans, and the opportunity cost of attending the university as opposed to working. In return, students receive a lifetime of higher earnings. For taxpayers, the study measures the benefits to taxpayers in Virginia 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 earnings and improved quality of life create benefits throughout Virginia as a whole.

The study uses a wide array of data that are based on several sources, including the FY 2023-24 academic and financial reports from VCU; industry and employment data from the Bureau of Labor Statistics and Census Bureau; outputs of Lightcast's impact model and MR-SAM model; and a variety of published materials relating education to social behavior.

Creating cultural connections by supporting VCU's Humphrey Fellows

The Hubert H. Humphrey Fellowship Program fosters an exchange of knowledge and mutual understanding, through which the U.S. joins in a significant partnership with participating countries.

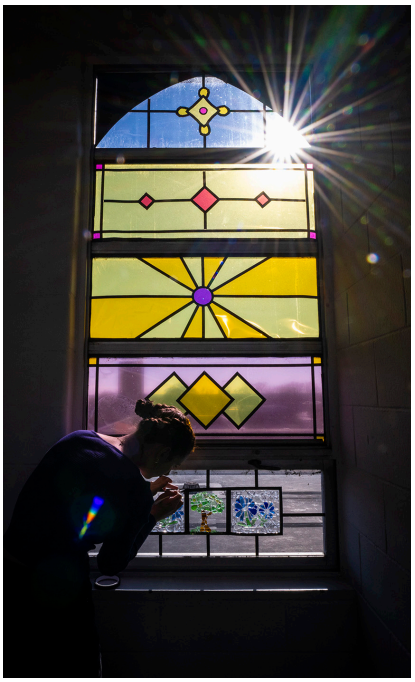
VCU is a Humphrey Fellowship Program site, welcoming mid-level professionals from around the world to campus. The program, a Fulbright exchange activity, brings accomplished professionals from selected countries of Africa, Asia, Latin America, the Caribbean, the Middle East, Europe, and Eurasia to the U.S. at a midpoint in their careers for 10 months of study and related practical professional experiences.

The Global Education Office (GEO) supports the Humphrey Fellows during their time at VCU by providing opportunities of global engagement with international students, events, and activities. The Fellows are often included in major events that allow them to represent their countries and professions, providing the VCU community the opportunity to learn more about their research and projects as they connect with other professionals while in the U.S.

Chapter 2:

Profile of Virginia Commonwealth University and the economy

VIRGINIA COMMONWEALTH UNIVERSITY (VCU)[5] is a comprehensive public research university that has been providing a wide range of relevant and high-value programs to students since the university was founded in 1838 as the Medical College of Hampden-Sydney. Over the past 187 years, the university has made many landmark achievements and has grown to include two primary campuses, serving students in the Richmond Metro Area, as well as a number of other locations, including a campus in Qatar. The university offers a variety of high-quality and affordable undergraduate, graduate, and professional course and degree options while cultivating community and sharing its rich history and traditions with each new class of students. In FY 2023-24, the university served over 31,400 students, supported by nearly 8,500 dedicated university faculty and staff. The VCU Health System employs an additional 14,640 workers.



The university provides exceptional educational opportunities in a variety of formats, including online and in-person options. With nearly 250 academic program offerings, the university's flexible learning models make it easy for students to explore interests and gain skills. The university's diverse program offerings include Fine Arts, Health Care Management, Homeland Security, Nuclear Engineering, Nurse Anesthesia, Nursing, Pharmacy, Rehabilitation Counseling, and many more. Additionally, the university creates opportunities for continuing education and offers custom training programs and professional development courses in partnership with area businesses and industry.

With **more than 200** academic program offerings, the university's flexible learning models make it easy for students to explore interests and gain skills.

The university offers a multitude of opportunities for students to connect and engage on campus, including more than 450 student organizations and 27 sports clubs, leadership opportunities through student government, and a calendar full of campus events. The university's 17:1 student-to-faculty ratio[6] ensures personalized attention and allows students to be supported by dedicated faculty. Further, students have access to a robust assortment of student support resources, including tutoring, academic advising, and more.

Beyond academics, the university enhances the lives of community members through connection, engagement, and service. Local residents and visitors alike are encouraged to cheer on the Rams on the court, field, or track, attend community events, visit university galleries, attend a show at the Shafer Street Playhouse, or visit the VCU libraries.

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6 National Center for Education Statistics Integrated Post-secondary Education Data System 2024 Fall Enrollment Survey. https://nces.ed.gov/ipeds/reported-data/234030?year=2024&surveyNumber=15

As a Carnegie R1 (Doctoral Very High Research Activity) University, the university prioritizes and supports relevant applied research aimed at solving contemporary, real-world problems and engages in a wide variety of research activity, with over $400 million in research expenditures in FY 2023-24. Research opportunities for undergraduate and graduate students abound at the university, and participation in cutting-edge projects is encouraged. Research and innovation at the university spur and foster entrepreneurial activity throughout the Commonwealth.

In addition to providing excellent academic opportunities for students, the university is a vital asset to state employers. The university adds highly trained human capital to the state workforce and provides custom training for businesses, tailoring continuing education and professional development courses to unique business needs. Through key partnerships with industry and organizations, the university provides enrichment opportunities for the community and supports economic development in the Commonwealth and beyond.

Chickahominy T.R.U.T.H. Project: Advancing health equity through community-led research

The Chickahominy T.R.U.T.H. Project (Trust, Research, Understand, Teach, and Heal) exemplifies VCU's commitment to mutually beneficial partnerships that create meaningful public value. Formed through collaboration between the Chickahominy Indian Tribe and VCU's Massey Comprehensive Cancer Center, this multi-year initiative investigates cancer risk, environmental health concerns, and healthcare mistrust in a historically underserved community.

Motivated by community concerns about elevated cancer rates and possible water contamination from a nearby landfill, the project brought together academic researchers and community leaders to co-design the research. The partnership emphasized cultural responsiveness, shared leadership, and community capacity-building. Tribe members received training in human subjects research, water testing, and qualitative interviewing, and participated directly in study design and fieldwork.

To date, the project has engaged over 150 residents in interviews and conducted water testing across the region. It has produced measurable outcomes including:

- Increased awareness of cancer risks and prevention
- Community training in research protocols
- Strengthened trust between VCU and the Chickahominy Tribe
- Individualized water quality reports to inform health decision-making
- Ongoing policy collaboration on environmental health and genetic equity

Campus impact has been significant as well. Insights from the partnership informed VCU's land acknowledgment statement and helped initiate a broader multi-stakeholder strategy for community investment in Charles City County.

The project has attracted external funding, including support from the Jeffress Trust and the Robert Wood Johnson Foundation, and is featured in peer-reviewed research on community-based cancer prevention.

The T.R.U.T.H. Project demonstrates how community-engaged research can improve health outcomes, foster trust, and create lasting institutional and statewide impact—serving as a model for equitable academic partnerships across Virginia.

VCU employee and finance data

The study uses two general types of information: 1) data collected from VCU and 2) state economic data obtained from various public sources and Lightcast's proprietary data modeling tools.[7] This chapter presents the basic underlying information from VCU used in this analysis and provides an overview of the Virginia economy.

Employee data

Data provided by VCU include information on faculty and staff by place of work and by place of residence. These data appear in Table 2.1. As shown, VCU employed 18,291 full-time and 4,816 part-time faculty and staff in FY 2023-24 (including student workers and VCU Health System employees). Of these, 97% worked and lived in Virginia. These data are used to isolate the portion of the employees' payroll and household expenses that remains in the state economy.

Revenues

Figure 2.1 shows VCU's annual revenues by funding source (including VCU Health System revenues)—a total of $5.2 billion in FY 2023-24. As indicated, tuition and fees comprised 6% of total revenue, and revenues from local, Virginia, and federal government sources comprised another 17%. All other revenue (i.e., auxiliary revenue, sales and services, interest, and donations) comprised the remaining 77%. These data are critical in identifying the annual costs experienced from the perspectives of students, taxpayers, and society.

Expenditures

Figure 2.2 displays VCU's expense data (including VCU Health System expenditures). The combined payroll at VCU, including student salaries and wages, amounted to $2.6 billion. This was equal to 56% of VCU's total expenses for FY 2023-24. Other expenditures, including operation and maintenance of plant, construction, depreciation, and purchases of supplies and services, made up $2.1 billion. When we calculate the impact of these expenditures in Chapter 3, we exclude depreciation expenses, as they represent a devaluing of VCU's assets rather than an outflow of expenditures.

Students

The university served 30,182 students taking courses for credit and 1,232 non-credit students in FY 2023-24. These numbers represent unduplicated student headcounts across the academic year and may differ from other student headcount reporting using

7 See Appendix 6 for a detailed description of the data sources used in the Lightcast modeling tools.

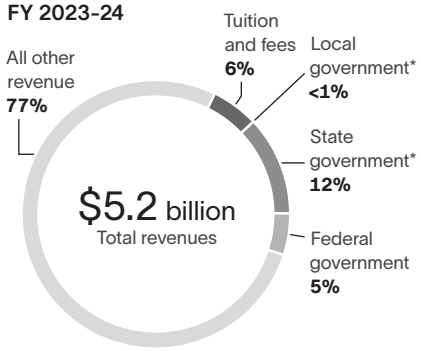
Table 2.1: Employee data, FY 2023-24

Full-time faculty and staff	18,291
Part-time faculty and staff	4,816
Total faculty and staff	**23,107**
% of employees who work in Virginia*	97%
% of employees who live in Virginia	97%

*Due to data limitations, the percentage of VCU employees who live in Virginia was used as a proxy for the percentage who work in the state.

Source: Data provided by VCU

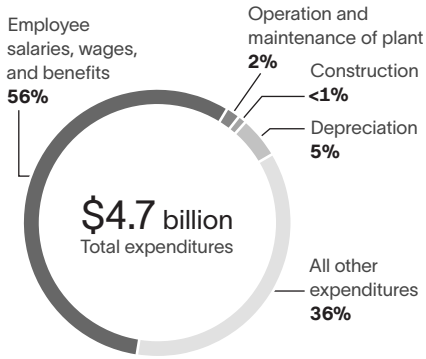
Figure 2.1: VCU revenues by source (including VCU Health System revenues), FY 2023-24



*Revenue from the government of Virginia and local government includes capital appropriations.

Source: Data provided by VCU

Figure 2.2: VCU expenses by function (including VCU Health System expenditures), FY 2023-24



Percentages do not sum to 100% due to rounding.

Source: Data provided by VCU

Census 2 headcounts. The breakdown of the student body by gender was 65% female and 35% male. The breakdown by ethnicity was 50% students of color, 42% white, and 8% unknown. The students' overall average age was 24 years old.[8] An estimated 67% of students remain in Virginia after finishing their time at the university and the remaining 33% settle outside Virginia.[9]

Table 2.2 summarizes the breakdown of the student population and their corresponding awards and credits by education level. In FY 2023-24, the university served 375 professional graduates, 437 doctoral graduates, 26 post-master's certificate completers, 1,382 master's degree graduates, 120 post-baccalaureate certificate completers, and 4,402 bachelor's degree graduates. Another 23,440 students enrolled in courses for credit but did not complete a degree during the reporting year. The university offered dual credit courses to high schools, serving a total of 247 students over the course of the year. Students not allocated to the other categories comprised the remaining 985 students.

Lightcast uses credit hour equivalents (CHEs) to track the educational workload of the students across both credit and non-credit students. One CHE is equal to one credit for credit students and 15 contact hours of classroom instruction per semester for non-credit students. The average number of CHEs per student was 22.8.

Table 2.2: Breakdown of student headcount and CHE production by education level, FY 2023-24

Category	Headcount	Total CHEs	Average CHEs
Professional graduates	375	16,378	43.7
Doctoral graduates	437	7,807	17.9
Post-master's certificate completers	26	176	6.8
Master's degree graduates	1,382	25,092	18.2
Post-baccalaureate certificate completers	120	1,895	15.8
Bachelor's degree graduates	4,402	97,175	22.1
Continuing students	23,440	560,365	23.9
Dual credit students	247	1,455	5.9
All other students	985	6,943	7.0
Total students	**31,414**	**717,284**	**22.8**

Source: Data provided by VCU

8 Unduplicated headcount, gender, ethnicity, and age data provided by VCU.

9 Lightcast used estimates based on Lightcast professional profiles data for VCU graduates from 2023 to 2025.

The Virginia economy

Since the university was first established, it has been serving Virginia by enhancing the workforce, providing local residents with easy access to higher education opportunities, and preparing students for highly skilled, technical professions. Table 2.3 summarizes the breakdown of the state economy by major industrial sector ordered by total income, with details on labor and non-labor income. Labor income refers to wages, salaries, and proprietors' income. Non-labor income refers to profits, rents, and other forms of investment income. Together, labor and non-labor income comprise the state's total income, which can also be considered the state's gross state product (GSP).

Table 2.3: Income by major industry sector in Virginia, 2024*

Industry sector	Labor income (millions)	Non-labor income (millions)	Total income (millions)**	% of total income	Sales (millions)
Government, Non-Education	$65,150	$35,062	$100,212	15%	$672,318
Professional & Technical Services	$80,405	$15,287	$95,692	14%	$140,602
Finance & Insurance	$31,593	$21,309	$52,902	8%	$91,781
Health Care & Social Assistance	$42,502	$6,678	$49,180	7%	$77,810
Manufacturing	$23,120	$25,155	$48,274	7%	$113,836
Retail Trade	$21,541	$21,020	$42,562	6%	$66,530
Construction	$25,736	$7,893	$33,628	5%	$63,310
Information	$12,915	$18,300	$31,215	5%	$52,041
Wholesale Trade	$15,150	$14,568	$29,718	4%	$48,278
Real Estate & Rental & Leasing	$18,366	$9,374	$27,740	4%	$63,026
Government, Education	$25,040	$0	$25,040	4%	$29,673
Administrative & Waste Services	$19,669	$4,416	$24,085	4%	$39,046
Transportation & Warehousing	$14,686	$6,166	$20,853	3%	$38,740
Accommodation & Food Services	$11,884	$8,085	$19,969	3%	$38,332
Management of Companies & Enterprises	$16,891	$1,366	$18,257	3%	$28,327
Other Services (except Public Administration)	$14,608	$1,832	$16,440	2%	$31,320
Utilities	$2,069	$6,987	$9,055	1%	$12,716
Educational Services	$6,049	$802	$6,851	1%	$10,405
Arts, Entertainment, & Recreation	$4,249	$1,777	$6,026	1%	$10,678
Agriculture, Forestry, Fishing & Hunting	$2,086	$1,723	$3,809	1%	$8,458
Mining, Quarrying, & Oil and Gas Extraction	$724	$1,892	$2,615	<1%	$4,172
Total	**$454,432**	**$209,691**	**$664,123**	**100%**	**$1,641,398**

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

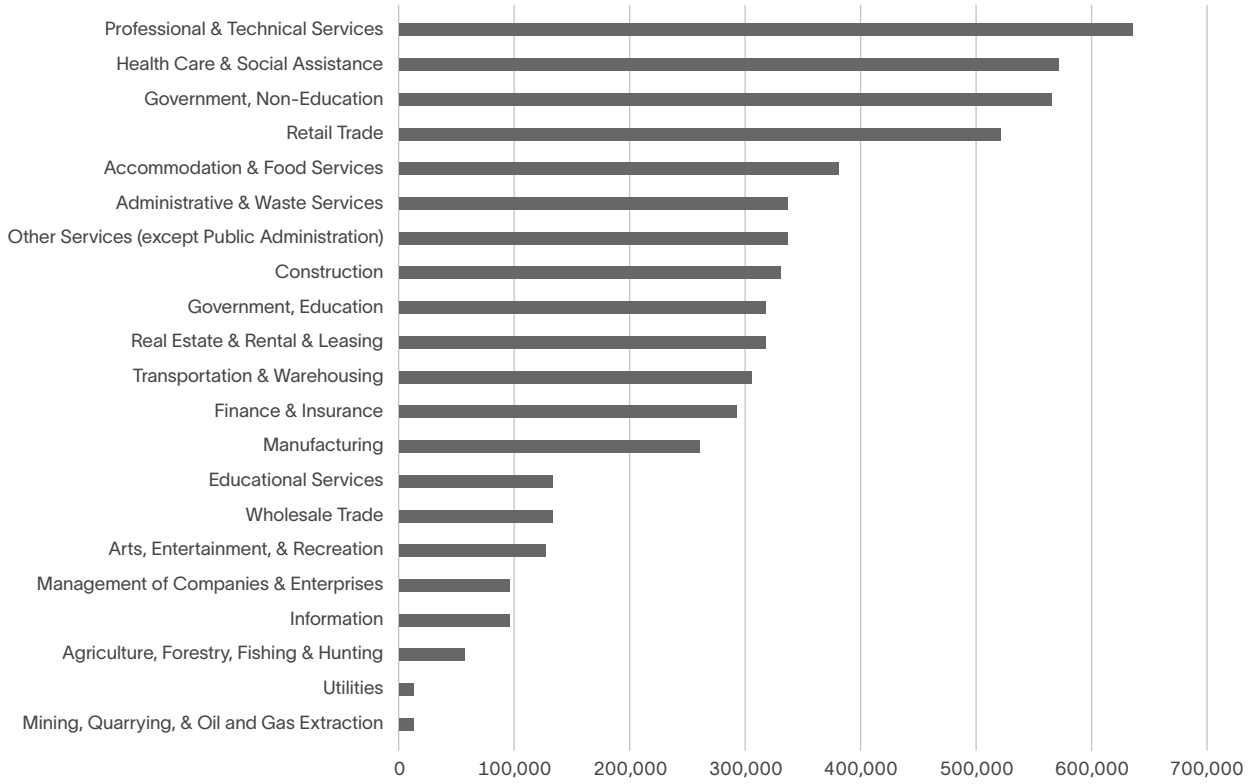
** Numbers may not sum to totals due to rounding.

Source: Lightcast industry data

As shown in Table 2.3, the total income, or GSP, of Virginia is approximately $664.1 billion, equal to the sum of labor income ($454.4 billion) and non-labor income ($209.7 billion). In Chapter 3, we use the total added income as the measure of the relative impacts of VCU on the state economy.

Figure 2.3 provides the breakdown of jobs by industry in Virginia. The Professional & Technical Services sector is the largest employer, supporting 638,505 jobs or 10.9% of total employment in the state. The second largest employer is the Health Care & Social Assistance sector, supporting 575,122 jobs or 9.8% of the state's total employment. Altogether, the state supports 5.9 million jobs.[10]

Figure 2.3: Jobs by major industry sector in Virginia, 2024*



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

Source: Lightcast employment data

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

Table 2.4 and Figure 2.4 present the mean earnings by education level in Virginia at the midpoint of the average worker's career. These numbers are derived from Lightcast's complete employment data on average earnings per worker in Virginia.[11] The numbers are then weighted by the university's student demographic profile and weighted by students' settlement patterns. 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 earn a bachelor's degree from the university can expect approximate wages of $71,400 per year within Virginia, approximately $34,600 more than someone with a high school diploma.

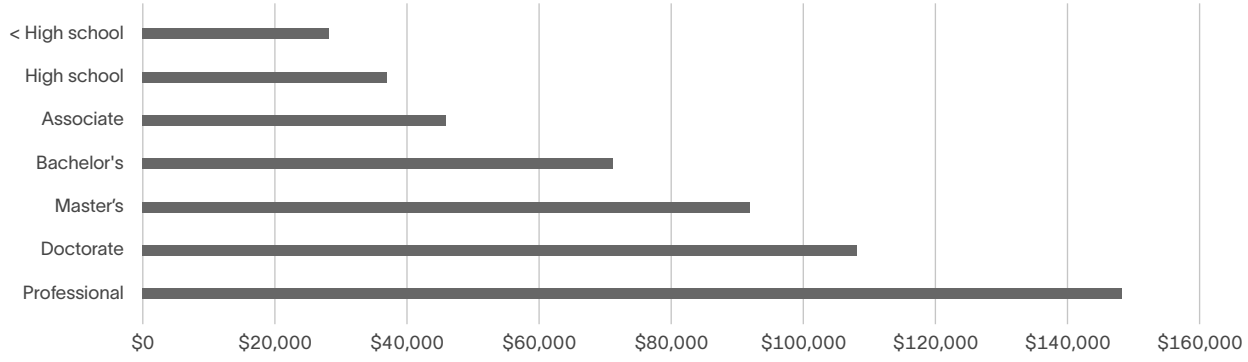
Table 2.4: Average earnings by education level at the career midpoint of the university's students

Education level	Earnings in Virginia	Difference from next lowest degree
Less than high school	$27,700	n/a
High school or equivalent	$36,800	$9,100
Associate degree	$46,300	$9,500
Bachelor's degree	$71,400	$25,100
Master's degree	$91,200	$19,800
Doctoral degree	$108,500	$17,300
Professional degree	$148,200	$57,000*

* Professional degree graduate earnings are compared to those of master's degree graduates when calculating the difference.

Source: Reflecting 2024 Lightcast employment data

Figure 2.4: Average earnings by education level in Virginia at the career midpoint of the university's students



Source: Reflecting 2024 Lightcast employment data

11 Wage rates in the Lightcast MR-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, Lightcast industry earnings-per-worker numbers are generally higher than those reported by other sources.

Chapter 3:

Economic impacts on the Virginia economy

The economic impact of VCU on the economy of Virginia is multi-faceted. VCU is an employer and buyer of goods and services. It attracts monies that otherwise would not have entered the state economy through its day-to-day university operations, construction operations, VCU Health System operations, research activities, entrepreneurial activities, and the expenditures of its visitors and students. The university also encourages its employees to volunteer in Virginia, where they can work with businesses and organizations to help meet their goals. Further, it provides students with the knowledge, skills, and abilities they need to become productive citizens and add to the overall output of the state.

IN THIS CHAPTER, we estimate the following economic impacts of VCU: 1) university operations spending impact, 2) university construction spending impact, 3) health system spending impact, 4) university research spending impact, 5) start-up and spin-off company impact, 6) visitor spending impact, 7) student spending impact, 8) university employee volunteerism impact, and 9) alumni impact, measuring the income added in the state as former students expand the state economy's stock of human capital.

When exploring each of these economic impacts, we consider the following hypothetical question:

How would economic activity change in Virginia if VCU and all the university's alumni did not exist in FY 2023-24?

Each of the economic impacts should be interpreted according to this hypothetical question. Another way to think about the question is to realize that we measure net impacts, not gross impacts. Gross impacts represent an upper-bound estimate in terms of capturing all activity stemming from VCU; however, net impacts reflect a truer measure of economic impact since they demonstrate what would not have existed in the state economy if not for VCU.

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

Another way to state the impact is in terms of **jobs**, a measure of the number of full- and part-time jobs that would be required to support the change in income. Finally, a frequently used measure is the **sales impact**, which comprises the change in business sales revenue in the economy as a result of increased economic activity. It is important to bear in mind, however, that much of this sales revenue leaves the state economy through intermediary transactions and costs.[12] All of these measures—added labor and non-labor income, total income, jobs, and sales—are used to estimate the economic impact results presented in this chapter. The analysis breaks out the impact measures into different components, each based on the economic effect that caused the impact. The following is a list of each type of effect presented in this analysis:

- The **initial effect** is the exogenous shock to the economy caused by the initial spending of money, whether to pay for salaries and wages, purchase goods or services, or cover operating expenses. This effect is only represented by labor income and sales and has zero non-labor income, as the initial effect of VCU

12 See Appendix 5 for an example of the intermediary costs included in the sales impact but not in the income impact.

spending stems exclusively from its employees' salaries, wages, and benefits, while any other direct expenditures of VCU are reflected in the sales amount.

- 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 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 below. Further, the term "indirect effect" as used by IMPLAN refers to the combined direct and indirect effects defined in this study. To avoid confusion, readers are encouraged to interpret the results presented in this chapter in the context of the terms and definitions listed above. Note that, regardless of the effects used to decompose the results, the total impact measures are analogous.

Lightcast	Initial	Direct	Indirect	Induced
IMPLAN	Direct	Indirect		Induced

Multiplier effects in this analysis are derived using Lightcast's Multi-Regional Social Accounting Matrix (MR-SAM) input-output model that captures the interconnection of industries, government, and households in the state. The Lightcast MR-SAM contains approximately 1,000 industry sectors at the highest level of detail available in the North American Industry Classification System (NAICS) and supplies the industry-specific multipliers required to determine the impacts associated with increased activity within a given economy. The multi-regional capacity of the MR-SAM allows impacts to be measured in the Richmond Metro Area and Virginia simultaneously, accounting for VCU's activity in each area, as well as each area's economic characteristics. In this analysis, impacts on the state include impacts from VCU's regional activity, as well as the indirect and induced multiplier effects from the university's activity in the rest of the Commonwealth. For more information on the Lightcast MR-SAM model and its data sources, see Appendix 6.

Net impacts reflect a truer measure of economic impact since they demonstrate what would not have existed in the state economy if not for VCU.

University operations spending impact

Faculty and staff payroll is part of the state's total earnings, and the spending of employees for groceries, apparel, and other household expenditures helps support businesses in the state. The university itself purchases supplies and services, and many of its vendors are located in Virginia. These expenditures create a ripple effect that generates still more jobs and higher wages throughout the economy.

Table 3.1 presents university expenditures (excluding construction, VCU Health System, and research) for the following three categories: 1) salaries, wages, and benefits, 2) operation and maintenance of plant, and 3) all other expenditures, including purchases for supplies and services. Also included in all other expenditures are expenses associated with grants and scholarships. Many students receive grants and scholarships that exceed the cost of tuition and fees. The university then dispenses this residual

Table 3.1: University expenses by function (excluding depreciation), FY 2023-24

Expense category	In-state expenditures (thousands)	Out-of-state expenditures (thousands)	Total expenditures (thousands)
Employee salaries, wages, and benefits	$484,705	$40,322	$525,027
Operation and maintenance of plant	$82,352	$7,517	$89,869
All other expenditures	$77,552	$186,877	$264,429
Total	**$644,609**	**$234,716**	**$879,325**

This table does not include expenditures on construction, VCU Health System, or research activity, as they are presented separately in the following sections.

Source: Data provided by VCU and the Lightcast impact model

financial aid to students who spend it on living expenses. Some of this spending takes place in the state and is therefore an injection of new money into the state economy that would not have happened if the university did not exist. In this analysis, we exclude depreciation expenses due to the way this measure is calculated in the national input-output accounts, and because depreciation represents the devaluing of the university's assets rather than an outflow of expenditures.[13]

The first step in estimating the multiplier effects of the university's operational expenditures is to map these categories of expenditures to the approximately 1,000 industries of the Lightcast MR-SAM model. Assuming that the spending patterns of university personnel approximately match those of the average U.S. consumer, we map salaries, wages, and benefits to spending on industry outputs using national household expenditure coefficients provided by Lightcast's national SAM. Excluding employees of the VCU Health System, approximately 92% of the university employees work in Virginia, and therefore we consider 92% of the salaries, wages, and benefits. For the other two expenditure categories (i.e., operation and maintenance of plant and all other expenditures), we assume the university's spending patterns approximately match national averages and apply the national spending coefficients for NAICS 902612 (Colleges, Universities, and Professional Schools (State Government)).[14] Operation and maintenance of plant expenditures are mapped to the industries that relate to capital construction, maintenance, and support, while the university's remaining expenditures are mapped to the remaining industries.

We now have three vectors of expenditures for the university: one for salaries, wages, and benefits; another for operation and maintenance of plant; and a third for the university's purchases of supplies and services. The next step is to estimate the portion of these expenditures that occurs inside the state. The expenditures occurring outside

Reviving high school outreach efforts

For more than 30 years, VCU Libraries has offered local high schools the opportunity for their students to borrow materials from VCU's print collection. Librarians also offered on-site instruction and/or tours to secondary students visiting with their librarian or teacher. In 2020, due to pandemic restrictions and the retirement of the librarian who led the high school outreach, the program paused instruction and library tours, although partner schools were still able to borrow materials. In 2023, VCU introduced the Richmond Talent Pathway, a scholarship and support system designed to recruit qualified students from Richmond city schools. The Strategic Enrollment Management and Student Success (SEMSS) office revived outreach efforts to prioritize support for schools with historically underserved students to make sure they feel comfortable using library spaces and asking for help from library staff. The project, which is expected to grow, has huge potential impact on admissions of deserving students from the targeted schools.

13 This aligns with the economic impact guidelines set by the Association of Public and Land-Grant Universities. Ultimately, excluding these measures results in more conservative and defensible estimates.

14 See Appendix 3 for a definition of NAICS.

the state are known as leakages. We estimate in-state expenditures using regional purchase coefficients (RPCs), a measure of the overall demand for the commodities produced by each sector that is satisfied by state suppliers, for each of the approximately 1,000 industries in the MR-SAM model.[15] 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 expenditures are multiplied, industry by industry, by the corresponding RPC to arrive at the in-state expenditures associated with the university. See Table 3.1 for a break-out of the expenditures that occur in-state. Finally, in-state spending is entered, industry by industry, into the MR-SAM model's multiplier matrix, which in turn provides an estimate of the associated multiplier effects on state labor income, non-labor income, total income, sales, and jobs.

Table 3.2 presents the economic impact of university operations spending. The people employed by the university and their salaries, wages, and benefits comprise the initial effect, shown in the top row of the table in terms of labor income, non-labor income, total added income, sales, and jobs. The additional impacts created by the initial effect appear in the next four rows under the section labeled *multiplier effect*. Summing the initial and multiplier effects, the gross impacts are $709.8 million in labor income and $180.6 million in non-labor income. This sums to a total impact of $890.5 million in total added income associated with the spending of the university and its employees in the state. This is equivalent to supporting 8,513 jobs.

Table 3.2: University operations spending impact, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$484,705**	**$0**	**$484,705**	**$879,325**	**5,056**
Multiplier effect					
Direct effect	$51,891	$29,252	$81,143	$140,573	621
Indirect effect	$16,346	$7,883	$24,229	$43,151	194
Induced effect	$156,907	$143,474	$300,382	$491,771	2,642
Total multiplier effect	**$225,145**	**$180,609**	**$405,754**	**$675,495**	**3,457**
Gross impact (initial + multiplier)	**$709,850**	**$180,609**	**$890,458**	**$1,554,820**	**8,513**
Less alternative uses of funds	-$208,406	-$218,251	-$426,657	-$776,963	-3,795
Net impact	**$501,444**	**-$37,642**	**$463,801**	**$777,858**	**4,718**

Source: Lightcast impact model

The $890.5 million in gross impact is often reported by researchers as the total impact. We go a step further to arrive at a net impact by applying a counterfactual scenario, i.e., what would have happened if a given event—in this case, the expenditure of in-state funds on the university—had not occurred. The university received an estimated 84% of its funding from sources within Virginia. This portion of the university's funding came from the tuition and fees paid by resident students, from the auxiliary revenue and

15 See Appendix 6 for a description of Lightcast's MR-SAM model.

donations from private sources located within the state, from taxes in Virginia and local taxes, and from the financial aid issued to students by the government of Virginia and local government. We must account for the opportunity cost of this in-state funding. Had other industries received these monies rather than the university, 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 university 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 the university, map this to the detailed industries of the MR-SAM model using national household expenditure coefficients, use the industry RPCs to estimate in-state spending, and run the in-state spending through the MR-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 3.2.

The total net impact of the university's operations is equal to the gross impact less the impact of the alternative use of funds—the opportunity cost of the state money. As shown in the last row of Table 3.2, the university's operations are labor-intensive, resulting in a net impact of $501.4 million in labor income; however, in the case of non-labor income, the adjustment for alternative uses of funds has a greater value than the generated initial and multiplier gross impact, making the net non-labor impact of operations spending negative. Nevertheless, the overall net impact is positive and significant. The labor and non-labor impacts sum to $463.8 million in total added income, equivalent to supporting 4,718 jobs. These impacts represent new economic activity created in the economy of Virginia solely attributable to the operations of the university.

The total net impact of the university's operations is **$463.8 million** in total added income, which is equivalent to supporting **4,718 jobs**.

University construction spending impact

In this section, we estimate the economic impact of the construction spending of the university. Because construction funding is separate from operations funding in the budgeting process, it is not captured in the operations spending impact estimated earlier. However, like 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 2023-24, the university spent a total of $42.8 million on various construction projects. Major construction projects included the Technology Operation Center, the Sanger 9 Innovation Suite, a STEM class laboratory, and renovation of floors 2 through 4 of the Technology Administration Building (TAB).

During FY 2023-24, the university spent a total of **$42.8 million** on various construction projects.

Assuming the university construction spending approximately matches national construction spending patterns of NAICS 902612 (Colleges, Universities, and Professional Schools (State Government)), we map the university's construction spending to the construction industries of the MR-SAM model. Next, we use the RPCs to estimate the portion of this spending that occurs 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 impact of a similar alternative uses of funds as found in the operations spending impact. 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. Again, since construction is so labor intensive, most of the added income stems from labor income as opposed to non-labor income.

Table 3.3 presents the impacts of the university's construction spending during FY 2023-24. Note the initial effect is purely a sales effect, so there is no initial change in labor or non-labor income. The FY 2023-24 the university's construction spending creates a net total short-run impact of $20.7 million in added income—the equivalent of supporting 213 jobs in Virginia.

Table 3.3: University construction spending impact, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$0**	**$0**	**$0**	**$42,842**	**0**
Multiplier effect					
Direct effect	$14,132	$4,334	$18,466	$34,766	180
Indirect effect	$3,970	$1,218	$5,188	$9,767	51
Induced effect	$8,194	$2,513	$10,706	$20,156	104
Total multiplier effect	**$26,296**	**$8,064**	**$34,361**	**$64,689**	**335**
Gross impact (initial + multiplier)	**$26,296**	**$8,064**	**$34,361**	**$107,531**	**335**
Less alternative uses of funds	-$6,685	-$6,991	-$13,676	-$24,872	-122
Net impact	**$19,611**	**$1,073**	**$20,684**	**$82,658**	**213**

Source: Lightcast impact model

Health system spending impact

In this section, we estimate the economic impact of the spending of the VCU Health System. Note that the broader health-related impacts of health care provided through the VCU Health System are beyond the scope of this analysis and are not included.

In FY 2023-24, $3.1 billion was spent on operations of the VCU Health System. To avoid any double counting, this spending was not included in the operations spending impacts previously reported. Any medical research expenses are accounted for in the university research spending impact and are not included here. Similar to the university operations spending impact, we exclude depreciation expenses.

Table 3.4: VCU Health System expenses by function (excluding depreciation), FY 2023-24

Expense category	In-state expenditures (thousands)	Out-of-state expenditures (thousands)	Total expenditures (thousands)
Salaries, wages, and benefits	$1,782,734	$4,110	$1,786,844
Operation and maintenance of plant	$20,743	$2,639	$23,382
All other expenses	$1,163,456	$145,257	$1,308,714
Total	**$2,797,719**	**$321,220**	**$3,118,939**

Source: Data provided by VCU and the Lightcast impact model

The methodology used here is similar to that used when estimating the university operations spending impact. Salaries, wages, and benefits are mapped to industries using national household expenditure coefficients. Assuming the VCU Health System has a spending pattern similar to that of the national average of general and surgical hospitals, we map their operation and maintenance of plant and other expenses to the industries of the MR-SAM model using spending coefficients for NAICS 622110 (General Medical & Surgical Hospitals). 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 3.5 presents the impacts of the VCU Health System expenses.

The payroll and number of people employed by the VCU Health System comprise the initial effect. The total impacts of health system expenses (the sum of the initial and multiplier effects) are $3.2 billion in labor income and $778.6 million in non-labor income. This sums to $4.0 billion in total added income and is equivalent to supporting 37,819 jobs.

Table 3.5: Health system spending impact, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$1,782,734**	**$0**	**$1,782,734**	**$3,118,939**	**14,606**
Multiplier effect					
Direct effect	$461,333	$153,241	$614,574	$1,267,786	7,018
Indirect effect	$198,081	$63,361	$261,442	$505,707	3,120
Induced effect	$776,829	$561,976	$1,338,805	$2,231,552	13,074
Total multiplier effect	**$1,436,243**	**$778,578**	**$2,214,821**	**$4,005,045**	**23,213**
Total impact (initial + multiplier)	**$3,218,977**	**$778,578**	**$3,997,555**	**$7,123,984**	**37,819**

Source: Lightcast impact model

University research spending impact

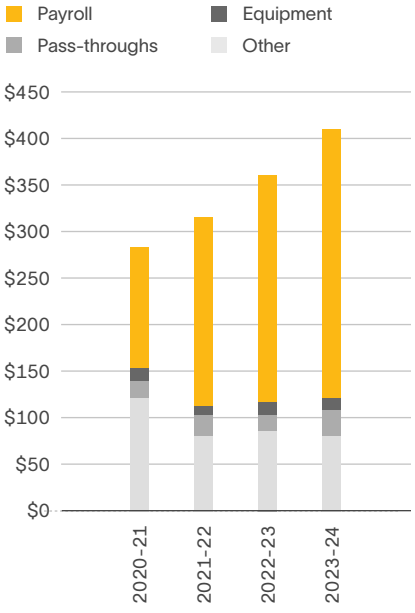
Similar to the day-to-day operations of the university, research activities impact the economy by employing people and requiring the purchase of equipment and other supplies and services. Figure 3.1 shows the university's research expenses by function—payroll, equipment, pass-throughs, and other direct costs (excluding indirect costs[16])—for the last four fiscal years. In FY 2023-24, the university spent $409.7 million on research and development activities. These expenses would not have been possible without funding from outside the state—the university received around 40% of its research funding from federal 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 MR-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 economy to support the research of the university, whether through research awards sponsored by Virginia 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 MR-SAM model—the only difference from our previous methodology—requires some exposition. We asked the university to provide information on expenditures by research and development field as they report to the National Science Foundation's Higher Education Research and Development Survey (HERD).[17] We map these fields of study to their respective industries in the MR-SAM model. The result is a distribution of research expenses to the various 1,000 industries that follows a weighted average of the fields of study reported by the university.

Initial, direct, indirect, and induced effects of the university's research expenses appear in Table 3.6. As with the operations spending impact, the initial effect consists of the 2,760 research jobs and their associated salaries, wages, and benefits. The university's research expenses have a total gross impact of $427.6 million in labor income and $97.7 million in non-labor income. This sums together to $525.3 million in added income, equivalent to 5,213 jobs. Accounting for the impact of the alternative uses of funds, net research expenditure impacts of the university are $374.3 million in labor income and $42.0 million in non-labor income. This sums to $416.3 million in total added income and is equivalent to supporting 4,242 jobs.

Figure 3.1: University research expenses by function (millions) (excluding indirect costs)



Source: Data provided by VCU

16 Because indirect costs are not necessarily spent during the analysis year, they are excluded from this analysis. Ultimately, excluding these measures results in more conservative and defensible estimates.

17 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.

The university's research activities create an economic impact beyond spending. There are impacts created through the entrepreneurial and innovative activities stemming from the university's research. Research activities that generate added productivity all have immense value in the state economy. However, the full magnitude of their value is difficult to quantify. Some of this value may be captured in the entrepreneurial and alumni impacts, presented later in this chapter. The broader spill-over effects, however, remain as additional value created beyond the scope of this analysis.

Table 3.6: University research spending impact, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$264,633**	**$0**	**$264,633**	**$409,663**	**2,760**
Multiplier effect					
Direct effect	$46,412	$14,989	$61,401	$92,244	595
Indirect effect	$14,297	$3,924	$18,221	$28,228	188
Induced effect	$102,278	$78,739	$181,017	$287,940	1,670
Total multiplier effect	**$162,987**	**$97,653**	**$260,640**	**$408,412**	**2,453**
Gross impact (initial + multiplier)	**$427,621**	**$97,653**	**$525,273**	**$818,075**	**5,213**
Less alternative uses of funds	-$53,349	-$55,640	-$108,989	-$197,463	-971
Net impact	**$374,272**	**$42,013**	**$416,284**	**$620,613**	**4,242**

Source: Lightcast impact model

VCU lab closing in on human Lyme disease vaccine

Led by Richard Marconi, Ph.D., VCU's Lyme disease research lab has spent over three decades tackling the nation's most common vector-borne illness. After developing the top canine Lyme disease vaccine in North America, Marconi's team is now advancing a multi-stage human vaccine—with early results showing 100% efficacy in animal models.

The breakthrough builds on chimeritope technology pioneered at VCU, which fuses protein segments from multiple strains of the Lyme-causing bacteria to create broad immune protection. The team's work, bolstered by funds from the NIH and private philanthropy, also includes a next-generation lateral flow diagnostic test designed for point-of-care use. Marconi is a professor in the Department of Microbiology and Immunology at the VCU School of Medicine.

Together, these tools aim to dramatically improve detection and prevention in a field where current public health advice remains limited to tick checks and insect repellent. "With the increasing incidence of Lyme disease, I couldn't accept that this was the best we could do—I thought there's got to be a better way," Marconi said.

Start-up and spin-off company impact

The university creates an environment that fosters innovation and entrepreneurship, evidenced by the number of related start-up and spin-off companies that have been created in the state. This subsection presents the economic impact of companies that would not have existed in the state but for the presence of the university. 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 the university.
- **Spin-off companies**: Companies created and fostered through programs offered by the university that support entrepreneurial business development, or companies that were created by faculty, students, or alumni as a result of their experience at the university.

The university creates an environment that fosters innovation and entrepreneurship, evidenced by the number of start-up and spin-off companies that have been created in the state.

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 company that was collected and reported by the university. Table 3.7 presents the number of employees for all start-up and spin-off companies related to the university that were active in Virginia during the analysis year.[18]

Table 3.7: Start-up and spin-off companies related to the university that were active in Virginia in FY 2023-24

	Number of companies	Number of employees
Start-up companies	25	46
Spin-off companies	55	66

Source: Data provided by VCU

First, we match each start-up and spin-off company to 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 MR-SAM to generate the direct, indirect, and induced multiplier effects.

18 When employee data was unavailable, a conservative assumption of one employee was used.

Table 3.8 presents the impact of the start-up companies. The initial effect is 46 jobs, equal to the number of employees at all start-up companies in the state (from Table 3.8). The corresponding initial effect on labor income is $8.2 million. The amount of labor income per job created by the start-up companies is much higher than in the previous sections. This is due to the higher average wages within the industries of the start-up companies. The total impacts (the sum of the initial, direct, indirect, and induced effects) are $15.9 million in added labor income and $7.9 million in non-labor income. This totals to $23.8 million in added income—or the equivalent of supporting 91 jobs.

Table 3.8: Impact of start-up companies related to the university, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$8,164**	**$4,287**	**$12,451**	**$19,618**	**46**
Multiplier effect					
Direct effect	$1,488	$572	$2,060	$3,497	9
Indirect effect	$616	$227	$844	$1,440	4
Induced effect	$5,614	$2,855	$8,469	$13,223	32
Total multiplier effect	**$7,718**	**$3,654**	**$11,372**	**$18,161**	**45**
Total impact (initial + multiplier)	**$15,882**	**$7,942**	**$23,823**	**$37,779**	**91**

Source: Lightcast impact model

Air Force awards $1.8M boost to VCU-developed trauma drug

Perfusion Medical is advancing the hemorrhagic shock drug PM-208, which was invented at the VCU School of Medicine. The drug—built on the research of surgery, physiology, and biophysics professor Martin Mangino, Ph.D.—works by restoring blood flow at the cellular level, helping stabilize trauma patients in critical moments.

In the past two years, Perfusion has secured more than $7 million in Department of Defense grants and raised an additional $1.85 million in investor capital. That funding is enabling the company to complete key regulatory and development milestones in 2025, including filing an investigational new drug application and beginning clinical trials with healthy participants at VCU.

PM-208 uses polyethylene glycol to draw excess water out of swollen tissues and back into blood vessels, reducing pressure on capillaries and improving circulation. It significantly outperformed conventional saline and blood-based treatments in pre-clinical studies.

Future trials could demonstrate its real-world impact in trauma patients at VCU Health. "This is a homegrown project at VCU," Mangino said. "We're blazing new ground."

Beyond battlefield use, the drug could have broader applications in cardiac illness, vascular disease, kidney injury, and more. A grant from the Air Force's venture arm, AFWERX, will support the development of compact packaging for field deployment—a key need for medics.

U.S. Sen. Mark Warner takes a tour of the VCU School of Medicine's Cottrell Surgical Innovation Suite, where Martin Mangino, Ph.D., conducts research. His findings led to the creation of the company Perfusion Medical. (VCU Enterprise Marketing and Communications)

Note that start-up companies have a strong and clearly defined link to the university. The link between the university and the existence of its spin-off companies, however, is less direct and is thus viewed as more subjective. We include the impacts from spin-off companies in the grand total impact presented later in the report since they represent entrepreneurial activities of the university. But we have included them separately here in case the reader would like to exclude the impacts from spin-off companies from the grand total impact.

Table 3.9: Impact of spin-off companies related to the university, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$3,840**	**$3,105**	**$6,945**	**$13,343**	**66**
Multiplier effect					
Direct effect	$841	$584	$1,425	$2,821	16
Indirect effect	$375	$251	$626	$1,236	7
Induced effect	$2,419	$1,814	$4,233	$7,755	42
Total multiplier effect	**$3,635**	**$2,649**	**$6,284**	**$11,811**	**66**
Total impact (initial + multiplier)	**$7,475**	**$5,754**	**$13,230**	**$25,155**	**132**

Source: Lightcast impact model

As demonstrated in Table 3.9, the university creates an environment that fosters innovation and entrepreneurship. As a result, the impact of spin-off companies related to the university is $7.5 million in added labor income and $5.8 million in non-labor income, totaling $13.2 million in added income—the equivalent of supporting 132 jobs.

Visitor spending impact

Thousands of out-of-state visitors came to the university in FY 2023-24 to participate in various activities, including commencement, sports events, and student orientation. Lightcast estimates that 33,914 out-of-state visitors attended events the university hosted in FY 2023-24.[19] Table 3.10 presents the average expenditures per person-trip for accommodation, food, transportation, and other personal expenses (including shopping and entertainment). Based on these figures, the gross spending of out-of-state visitors totaled $9.4 million in FY 2023-24. However, some of this spending includes monies paid to the university through non-textbook items (e.g., event tickets, food, etc.). These have already been accounted for in the operations spending impact and should thus be removed to avoid double-counting. We estimate that on-campus sales generated by out-of-state visitors totaled $2.0 million. The net sales from out-of-state visitors in FY 2023-24 thus come to $7.4 million.

Table 3.10: Average per-trip visitor costs and sales generated by out-of-state visitors in Virginia, FY 2023-24*

Accommodation	$56
Food	$111
Entertainment and shopping	$79
Transportation	$32
Total expenses per visitor	**$278**
Number of out-of-state visitors	*33,914*
Gross sales	$9,421,787
On-campus sales (excluding textbooks)	-$2,012,269
Net off-campus sales	**$7,409,517**

*Due to data limitations, visitor expenses reflect estimates from universities Lightcast has worked with that collect this information. These expenses have been adjusted to account for the length of stay of out-of-state visitors, which was an average of one night. Accommodation and transportation have been adjusted downward to recognize that, on average, two visitors share these costs. Numbers may not sum to total due to rounding.

Source: Sales calculations estimated by Lightcast based on data provided by VCU

Thousands of out-of-state visitors came to the university in FY 2023-24 to participate in various activities, including commencement, sports events, and orientation.

Calculating the increase in income as a result of visitor spending again requires use of the MR-SAM model. The analysis begins by discounting the off-campus sales generated 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 MR-SAM model. The model runs the net sales figures through the multiplier matrix to arrive at the multiplier effects.

19 Due to data limitations, Lightcast estimated visitor counts using a combination of visitor data and student origin data provided by VCU, as well as a conservative assumption that each student had two visitors during the analysis year who stayed one night. Additionally, for sporting events, one-third of attendance was assumed to consist of students and employees, whom are excluded from visitor counts, and student origin data was applied to estimate whether the remaining attendees visited from outside Virginia.

As shown in Table 3.11, the net impact of visitor spending in FY 2023-24 is $3.1 million in labor income and $2.3 million in non-labor income. This sums to $5.4 million in added income and is equivalent to supporting 128 jobs.

Table 3.11: Visitor spending impact, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$0**	**$0**	**$0**	**$7,410**	**0**
Multiplier effect					
Direct effect	$869	$629	$1,498	$2,807	45
Indirect effect	$909	$704	$1,614	$3,045	34
Induced effect	$1,293	$995	$2,288	$4,176	49
Total multiplier effect	**$3,072**	**$2,328**	**$5,400**	**$10,029**	**128**
Total impact (initial + multiplier)	**$3,072**	**$2,328**	**$5,400**	**$17,438**	**128**

Source: Lightcast impact model

Family Weekend 2023: A record-breaking weekend at Virginia Commonwealth University

October 2023 marked a milestone for VCU, as Family Programs hosted the most highly attended Parent and Family Weekend in VCU history. With 716 students and 1,491 adults registered, the event brought together a vibrant community of 1,822 family members. This remarkable turnout underscored the strong bonds between VCU students and their families, as well as their enthusiasm for engaging with the university community.

A weekend of connection and celebration

First-year students made up the majority of attendees, accounting for 86% of registrations, followed by sophomores (7%), juniors (5%), and seniors (2%). The weekend offered a wide variety of programming and events designed to foster connections and showcase the best of VCU. Among the top five most attended events were the Closing Brunch with 1,560 participants, the Ramily Rally with 900 attendees, Paint Events with 441 participants, BINGO with 408 players, and Ghost Tours that intrigued 310 guests.

Kenlee Andreu, Assistant Director of Student Advocacy, shared, "My favorite event during Family Weekend was the Halloween-themed BINGO night. So many families showed up in costume and contributed to the most fun environment." BINGO became a highlight of the weekend. Andreu also remarked, "What I was most proud of during Family Weekend was how many of our colleagues volunteered their time helping us with events or hosting their own for families."

What attendees loved most

Families appreciated the opportunity to see their students and meet other families, praising the organization of the event and the quality of communication leading up to the weekend. Andreu noted, "We hope families leave Family Weekend feeling proud to be part of the VCU community, with a greater understanding of their student's experience. It's an opportunity for students to welcome their loved ones into their world, show them around their new home, and create memories together in this new chapter." The food at the Ramily Rally and Brunch, Family BINGO, Spooky BINGO, Paint Parties, STEM Building Tours, Choir Performances, free parking, and discounted athletics tickets were all highly praised.

A special event: the Chosen Ramily Celebration

This year also marked the inaugural 'Chosen Ramily' event, a celebration of inclusivity. Kenlee Andreu explained, "The Chosen Ramily Celebration was an idea I came up with during my interview, inspired by the Family Programs' value of recognizing and supporting all concepts of family. While we must engage families who are supportive and invested in their student's experience, I felt it was important not to exclude students who have found their families here at VCU." This event allowed even more students and families to feel connected and represented within the VCU community.

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Student spending impact

Both in-state and out-of-state students contribute to the student spending impact of the university. However, not all of these students can be counted toward the impact. Of the in-state students, only the impact from those students who were retained, or who would have left the state to seek education elsewhere had they not attended the university, is measured. Students who would have stayed in the state anyway are not counted toward the impact since their monies would have been added to the Virginia economy regardless of the university. In addition, only the out-of-state students who relocated to Virginia to attend the university are considered. Students who commute from outside the state or take courses online are not counted towards the student spending impact because they are not adding money from living expenses to the state.

The total impact of student spending is **$151.7 million** in total added income and is equivalent to supporting **2,629 jobs**.

While there were 26,962 students attending the university who originated from Virginia (excluding dual credit high school students), not all of them would have remained in the state if not for the existence of the university. We apply a conservative assumption that 10% of these students would have left Virginia for other education opportunities if the university did not exist.[20] Therefore, we recognize that the in-state spending of 2,696 students retained in the state is attributable to the university. These students, called retained students, spent money at businesses in the state for everyday needs such as groceries, accommodation, and transportation. Of the retained students, we estimate 578 lived on campus while attending the university. While these students spend money while

20 See Appendix 2 for a sensitivity analysis of the retained student variable.

attending the university, we exclude most of their spending for room and board since these expenditures are already reflected in the impact of the university's operations.

Relocated students are also accounted for in the university's student spending impact. An estimated 4,016 students came from outside the state and lived off campus while attending the university in FY 2023-24. Another estimated 189 out-of-state students lived on campus while attending the university. We apply the same adjustment as described above to the students who relocated and lived on campus during their time at the university. Collectively, the off-campus expenditures of out-of-state students supported jobs and created new income in the state economy.[21]

The average costs for students appear in the first section of Table 3.12, equal to $26,740 per student. Note that this table excludes expenses for books and supplies, since many of these costs are already reflected in the operations spending impact discussed in the previous section. We multiply the $26,740 in annual costs by the 6,134 students who either were retained or relocated to the state because of the university and lived in-state but off campus. This provides us with an estimate of their total spending. For students living on campus, we multiply the per-student cost of off-campus food purchases (assumed to be equal to 25% of room and board), personal expenses, and transportation by the number of students who lived in the state but on campus while attending (768 students). Altogether, off-campus spending of relocated and retained students generated gross sales of $174.0 million. This figure, once net of the monies paid to student workers, yields net off-campus sales of $170.6 million, as shown in the bottom row of Table 3.12.

Table 3.12: Average student costs and total sales generated by relocated and retained students in Virginia, FY 2023-24

Room and board	$18,254
Personal expenses	$5,411
Transportation	$3,075
Total expenses per student	**$26,740**
Number of students retained	*2,696*
Number of students relocated	*4,205*
Gross retained student sales	$64,178,111
Gross relocated student sales	$109,851,115
Total gross off-campus sales	**$174,029,226**
Wages and salaries paid to student workers*	$3,406,999
Net off-campus sales	**$170,622,227**

* This figure reflects only the portion of payroll that was used to cover the living expenses of relocated and retained student workers who lived in the state.

Source: Student costs and wages provided by VCU. The number of relocated and retained students who lived in the state off campus or on campus while attending is derived by Lightcast from the student origin data and in-term residence data provided by VCU.

21 Online students and students who commuted to Virginia from outside the state are not considered in this calculation because it is assumed their living expenses predominantly occurred in the state where they resided during the analysis year. We recognize that not all online students live outside the state, but keep the assumption given data limitations.

Estimating the impacts generated by the $170.6 million in student spending follows a procedure similar to that of the operations spending impact described above. We distribute the $170.6 million in sales to the industry sectors of the MR-SAM model, apply RPCs to reflect in-state spending, and run the net sales figures through the MR-SAM model to derive multiplier effects.

Table 3.13 presents the results. The initial effect is purely sales-oriented and there is no change in labor or non-labor income. The impact of relocated and retained student spending thus falls entirely under the multiplier effect. The total impact of student spending is $90.7 million in labor income and $61.0 million in non-labor income. This sums together to $151.7 million in total added income and is equivalent to supporting 2,629 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.

Table 3.13: Student spending impact, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$0**	**$0**	**$0**	**$170,622**	**0**
Multiplier effect					
Direct effect	$35,999	$24,411	$60,409	$110,108	1,058
Indirect effect	$20,847	$14,397	$35,244	$66,469	640
Induced effect	$33,841	$22,233	$56,074	$100,605	932
Total multiplier effect	**$90,687**	**$61,040**	**$151,727**	**$277,183**	**2,629**
Total impact (initial + multiplier)	**$90,687**	**$61,040**	**$151,727**	**$447,805**	**2,629**

Source: Lightcast impact model

University employee volunteerism impact

Beyond positively impacting the state through the activities occurring at VCU, the university directly impacts the state economy through its facilitation and support of volunteer activities. Due to data limitations, student volunteer hours are unaccounted for in this analysis. Further, employee hours reported are limited to community service leave. Notably, university employee community service leave is used for various community engagement purposes, including time spent meeting with the employee's child's teachers and school officials. The context of these data limitations emphasizes the limited scope of volunteer activity analyzed in this study. Nevertheless, the value of volunteerism demonstrated in this analysis does have implications for the broader volunteer activity attributable to the university.

Overall, 1,217 university employee volunteers supported organizations and causes across the state in FY 2023-24. Altogether, university employees volunteered 12,744 hours of their time in Virginia. According to Independent Sector,[22] the only national membership organization that brings together the charitable community, the average value of a volunteer hour in Virginia in 2022 was $33.93. Multiplying this by the hours university employees volunteered amounts to $432.4 thousand in value to the community.

Next, we convert the $432.4 thousand in value or, for the purposes of economic impact modeling, earnings by industry to sales using the MR-SAM model's earnings-to-sales ratios and run the sales figures through the MR-SAM model to derive multiplier effects. Unlike other components of this analysis, we do not include the initial effect. This is because volunteers are not paid employees of the businesses and organizations, so there is no initial labor income associated with their increased productivity or increased initial non-labor income associated with the business output. Therefore, we only

University employee volunteer hours are valued at **$432.4 thousand**.

Table 3.14: University employee volunteerism impact, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$0**	**$0**	**$0**	**$0**	**0**
Multiplier effect					
Direct effect	$145	$15	$160	$304	5
Indirect effect	$81	$8	$89	$169	3
Induced effect	$319	$33	$351	$641	9
Total multiplier effect	**$544**	**$55**	**$600**	**$1,114**	**17**
Total impact (initial + multiplier)	**$544**	**$55**	**$600**	**$1,114**	**17**

Source: Lightcast impact model

22 By state value per volunteer hour was provided by Independent Sector (see https://independentsector.org/resource/vovt_details/).

include the multiplier effects from the volunteers in the total impact. The productivity of university employee volunteers allows leaders of the businesses and organizations to devote resources to other projects, generating effects throughout the economy—the multiplier effects. Table 3.14 outlines this process. In FY 2023-24, the university volunteers added $544.4 thousand in labor income and $55.4 thousand in non-labor income. The total added income from university employee volunteers to the Virginia economy sums to $599.8 thousand in FY 2023-24, equivalent to supporting 17 jobs in the state.

da Vinci Center for Innovation SONAR

The SONAR project exemplifies how the da Vinci Center for Innovation's innovation, entrepreneurship, and design-thinking programs are directly fueling the regional economy and creating social value. Sponsored by Bank of America and Virginia's Special Olympics, this student-led initiative aimed to solve a real-world problem: outdated and inefficient volunteer coordination at Special Olympics events. The result was a scalable, user-friendly digital solution developed through intensive research, human-centered design, and cross-disciplinary collaboration.

This project is a model of how industry partnerships create meaningful pathways for students to gain hands-on, market-relevant experience. By engaging directly with corporate and nonprofit partners, students from diverse academic backgrounds—including marketing, management, information systems, and interdisciplinary studies—worked in teams to research, prototype, and present a tech-based solution with real-world applicability. Their work not only provided a roadmap for a digital platform but also contributed to an ongoing effort by Bank of America to launch the app in time for the 2027 Summer Special Olympics.

The da Vinci Center for Innovation's infrastructure supported the project with design-thinking methodology, faculty mentorship, and access to sponsor networks, showcasing a robust system that empowers student-led ventures. Through the use of journey maps, user personas, and agile design processes, students were equipped with skills that are directly transferable to the creative economy and broader workforce.

Moreover, the SONAR project embodies the power of interdisciplinary initiatives to address complex social challenges. The design addressed the needs of multiple stakeholders—athletes, coaches, volunteers, and event administrators—many of whom represent under-resourced or marginalized communities. In doing so, students created a solution that improves operational efficiency, promotes inclusivity, and enhances volunteer engagement, all of which contribute to stronger civic and economic systems.

The project also demonstrated excellence in applied research and service, with outputs that included low-, medium-, and high-fidelity prototypes, a comprehensive SWOT analysis, stakeholder engagement plans, and a long-term implementation strategy. By aligning with the goals of both corporate and nonprofit partners, the SONAR team delivered not just a functional product, but also a model of how academic programs can drive regional innovation and economic impact.

In short, the SONAR project is a clear reflection of the da Vinci Center for Innovation's commitment to advancing innovation, entrepreneurship, and social good through interdisciplinary learning and community partnership.

Alumni impact

An alumni impact is a type of economic impact that is uniquely attributable to education and training institutions In this section, we estimate the economic impacts stemming from the added labor income of alumni in combination with their employers' added non-labor income. This impact is based on the number of students who have attended the university *throughout its history.* We then use this total number to consider the impact of those students in the single FY 2023-24. Former students who earned a degree as well as those who may not have finished their degree or did not take courses in pursuit of achieving a degree are considered alumni.

The alumni impact of the university stems from the added human capital—the knowledge, creativity, imagination, and entrepreneurship—found in its alumni.

While VCU creates an economic impact through its operations, construction, VCU Health System, research, entrepreneurial, visitor, and student spending, as well as volunteerism, the alumni impact stems from the added human capital—the knowledge, creativity, imagination, and entrepreneurship—found in its alumni. While attending the university, students gain experience, education, and the knowledge, skills, and abilities that increase their productivity and allow them to command a higher wage once they enter the workforce. But the reward of increased productivity does not stop there. Talented professionals make capital more productive too (e.g., buildings, production facilities, equipment). The employers of university alumni enjoy the fruits of this increased productivity in the form of additional non-labor income (i.e., higher profits).

The methodology here differs from the previous impacts in one fundamental way. Whereas the previous spending impacts depend on an annually renewed injection

of new sales into the state economy, the alumni impact is the result of years of past instruction and the associated accumulation of human capital. The initial effect of alumni is made up of two main components. The first and largest of these is the added labor income of the university's former students. The second component of the initial effect is the added non-labor income of the businesses that employ former students of the university.

We begin by estimating the portion of alumni who are employed in the workforce. To estimate the historical employment patterns of alumni in the state, we use the following sets of data or assumptions: 1) settling-in factors to determine how long it takes the average student to settle into a career;[23] 2) death, retirement, and unemployment rates from the National Center for Health Statistics, the Social Security Administration, and the Bureau of Labor Statistics; and 3) state migration data from the Internal Revenue Service.[24] The result is the estimated portion of alumni from each previous year who were still actively employed in the state as of FY 2023-24.

The next step is to quantify the skills and human capital that alumni acquired from the university. We use the students' production of CHEs as a proxy for accumulated human capital. The average number of CHEs completed per student in FY 2023-24 was 22.8. To estimate the number of CHEs present in the workforce during the analysis year, we use the university's historical student headcount over the past 43 years, from FY 1981-82 to FY 2023-24. We apply a 43-year time horizon to include all alumni active in the state workforce who have not reached the average retirement age of 67. The time horizon, or number of years in the workforce, is calculated by subtracting the average age of the university's students from the retirement age of 67. However, the alumni impact is based on credits achieved and not headcount, because the value of education is more attributable to credits earned. Therefore, we calculate and use an average age per credit rather than per student.

We multiply the 22.8 average CHEs per student by the headcounts that we estimate are still actively employed from each of the previous years of enrollment.[25] Students who enroll at the university more than one year are counted at least twice in the historical enrollment data. However, CHEs remain distinct regardless of when and by whom they were earned, so there is no duplication in the CHE counts. We estimate there are approximately 10.6 million CHEs from alumni active in the workforce.

Next, we estimate the value of the CHEs, or the skills and human capital acquired by university alumni. This is done using the *incremental* added labor income stemming from the students' higher wages. The incremental added labor income is the difference between the wage earned by university alumni and the alternative wage they would

23 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.

24 According to a study performed by Pew Research Center, people who have already moved are more likely to move again than people who do not move. Therefore, migration rates are dampened to account for the idea that if they do not move in the first two years after leaving the university, then they are less likely to migrate out compared to the average person.

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

have earned had they not attended the university. Using the state incremental earnings, credits required, and distribution of credits at each level of study, we estimate the average value per CHE to equal $353. This value represents the state average incremental increase in wages that alumni of the university received during the analysis year for every CHE they completed.

Because workforce experience leads to increased productivity and higher wages, the value per CHE varies depending on the students' workforce experience, with the highest value applied to the CHEs of students who had been employed the longest by FY 2023-24, and the lowest value per CHE applied to students who were just entering the workforce. More information on the theory and calculations behind the value per CHE appears in Appendix 7. 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 sum the products together. This calculation yields approximately $3.8 billion in gross labor income from increased wages received by former students in FY 2023-24 (as shown in Table 3.15).

Table 3.15: Number of CHEs in workforce and initial labor income created in Virginia, FY 2023-24

Number of CHEs in workforce	10,642,549
Average value per CHE	$353
Initial labor income, gross	**$3,755,600,743**
Adjustments for counterfactual scenarios	
Percent reduction for alternative education opportunities	15%
Percent reduction for adjustment for labor import effects	50%
Initial labor income, net	**$1,596,130,316**

Source: Lightcast impact model

The next two rows in Table 3.15 show two adjustments used to account for counterfactual outcomes. As discussed above, counterfactual outcomes in economic analysis represent what would have happened if a given event had not occurred. The event in question is the education and training provided by the university and subsequent influx of 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 the university does not exist, we assume a portion of 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 added labor income that accrues to those students cannot be counted toward the added labor income from alumni. The adjustment for alternative education opportunities amounts to a 15% reduction of the $3.8 billion in added labor income. This means that 15% of the added labor income from alumni would have been generated in the state anyway, even if the university did not exist. For more information on the alternative education adjustment, see Appendix 8.

The other adjustment in Table 3.15 accounts for the importation of labor. Suppose the university 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 Virginia. We refer to this as the labor import effect. Lacking information on its possible magnitude, Lightcast conservatively assumes 50% of the jobs that students fill at businesses in the state could have been filled by workers recruited from outside the state if the university did not exist.[26] Consequently, the gross labor income must be adjusted to account for the importation of this labor, since it would have happened regardless of the presence of the university. We conduct a sensitivity analysis for this assumption in Appendix 2. With the 50% adjustment, the net added labor income added to the economy comes to $1.6 billion, as shown in Table 3.15.

The $1.6 billion in added labor income appears under the initial effect in the labor income column of Table 3.16. To this we add an estimate for initial non-labor income. As discussed earlier in this section, businesses that employ former students of the university see higher profits as a result of the increased productivity of their capital assets. To estimate this additional income, we allocate the initial increase in labor income ($1.6 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 MR-SAM model.[27] Using a crosswalk created by National Center for Education Statistics (NCES) and the Bureau of Labor Statistics, we map the breakdown of the university'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 MR-SAM model to map the occupational distribution of the $1.6 billion in initial labor income effects to the detailed industry sectors in the MR-SAM model.[28]

Once these allocations are complete, we apply the ratio of non-labor to labor income provided by the MR-SAM model for each sector to our estimate of initial labor income. This computation yields an estimated $580.0 million in added non-labor income attributable to the university's alumni. Summing initial labor and non-labor income together provides the total initial effect of alumni productivity in the Virginia economy, equal to approximately $2.2 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 MR-SAM model. We then run the values through the MR-SAM's multiplier matrix.

Table 3.16 shows the multiplier effects of alumni. Multiplier effects occur as alumni generate an increased demand for consumer goods and services through the expenditure

26 A similar assumption is used by Walden (2014) in his analysis of the Cooperating Raleigh Colleges. A sensitivity analysis of how the alumni impact would change if the assumption differed is available in Appendix 2.

27 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).

28 For example, if the MR-SAM model indicates that 20% of jobs in SOC 15-1252 (Software Developers) occur in NAICS 541512 (Computer Systems Design Services) in the state, we allocate 20% of the initial labor income effect under SOC 15-1252 to NAICS 541512.

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 university's alumni. The final results are $1.4 billion in added labor income and $496.2 million in added non-labor income, for an overall total of $1.9 billion in multiplier effects. The grand total of the alumni impact is $4.1 billion in total added income, the sum of all initial and multiplier labor and non-labor income effects. This is equivalent to supporting 45,718 jobs.

Table 3.16: Alumni impact, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
Initial effect	**$1,596,130**	**$580,001**	**$2,176,131**	**$5,523,263**	**23,455**
Multiplier effect					
Direct effect	$293,182	$114,194	$407,376	$808,793	4,701
Indirect effect	$123,909	$48,841	$172,750	$339,655	2,066
Induced effect	$1,011,129	$333,122	$1,344,251	$2,688,594	15,496
Total multiplier effect	**$1,428,221**	**$496,156**	**$1,924,377**	**$3,837,042**	**22,263**
Total impact (initial + multiplier)	**$3,024,351**	**$1,076,157**	**$4,100,508**	**$9,360,305**	**45,718**

Source: Lightcast impact model

Promoting cultural connections through study abroad in Florence, Italy

The Global Education Office and the Department of Communication Arts in the School of the Arts at VCU offer a unique opportunity to study on-site in one of the world's foremost cultural capitals. Florence is a quintessential Italian city with cobblestone streets and art museums that are filled with some of the most impressive and historical art and architecture ever created.

In an effort to allow students to remain connected to cultural and art historical references, the study abroad program, "Florence Revealed: Drawing from the Wellspring of Renaissance Thought and Vision" has been established. This program provides students with the opportunity to spend the entire month of June in the heart of Florence, Italy. Through daily life-drawing sessions conducted all'aperto (in the open), students immerse themselves in the cultural heritage of the city. Excursions to venerable landmark piazzas, churches, and museums provide students with the essential primary source material for their city-based sketchbook entries, while providing an art historical foundation to the program at large. A second part of the program, titled Beyond the Walls of Florence, is dedicated to the creation of nature studies that range from (macro) views of the city itself to (micro) studies of Tuscan flora. Explorations of Florence's surrounding hills (Fiesole, Bellosguardo, Piazzale Michelangelo, etc.) and visits to Florence's fabled Boboli Gardens and the Orto Botanico (Botanical Garden) provide students with primary source material from which to create their nature-based sketchbook entries, while excursions to Siena, Pisa, and Venice serve to put the Quattrocento Fiorentino into the broader cultural context of its time.

Total VCU impact

The total economic impact of VCU on Virginia can be generalized into two broad types of impacts. First, on an annual basis, VCU generates a flow of spending that has a significant impact on the state economy. The impacts of this spending are captured by the university operations, construction, VCU Health System operations, research, entrepreneurial, visitor, and student spending impacts, along with the university employee volunteerism impact. While not insignificant, these impacts do not capture the effects of the education provided by the university. The academic operations of the university foster real-world learning that equips students for career success and help employers find necessary talent. Every year, a new cohort of students enters the state workforce with the new knowledge and interdisciplinary experiences gained at the university, and a portion of alumni working in the state continues to add to the state economy.

Table 3.17: Total VCU impact, FY 2023-24

	Labor income (thousands)	Non-labor income (thousands)	Total income (thousands)	Sales (thousands)	Jobs supported
University operations spending	$501,444	-$37,642	$463,801	$777,858	4,718
University construction spending	$19,611	$1,073	$20,684	$82,658	213
Health system spending	$3,218,977	$778,578	$3,997,555	$7,123,984	37,819
University research spending	$374,272	$42,013	$416,284	$620,613	4,242
Start-up and spin-off companies	$23,357	$13,696	$37,053	$62,934	223
Visitor spending	$3,072	$2,328	$5,400	$17,438	128
Student spending	$90,687	$61,040	$151,727	$447,805	2,629
University employee volunteerism	$544	$55	$600	$1,114	17
Alumni	$3,024,351	$1,076,157	$4,100,508	$9,360,305	45,718
Total impact	**$7,256,315**	**$1,937,297**	**$9,193,613**	**$18,494,708**	**95,707**
% of the Virginia economy	1.6%	0.9%	1.4%	1.1%	1.6%

Source: Lightcast impact model

Table 3.17 displays the grand total impacts of VCU on the Virginia economy in FY 2023-24. For context, the percentages of VCU compared to the total labor income, total non-labor income, combined total income, sales, and jobs in Virginia, as presented in Table 2.3 and Figure 2.3, are included. The total added value of VCU is **$9.2 billion**, equivalent to **1.4%** of the GSP of Virginia. By comparison, this contribution that VCU provides on its own is larger than the entire Arts, Entertainment, & Recreation industry in Virginia. VCU's total impact supported **95,707 jobs** in FY 2023-24. For perspective,

this means that **one out of every 61 jobs** in Virginia is supported by the activities of VCU and the university's students.

These impacts from VCU and the university's students stem from different industry sectors and spread throughout the state economy. Table 3.18 displays the total impact of VCU by each industry sector based on their two-digit NAICS code. The table shows the total impact of the university's operations, construction, VCU Health System operations, research, start-up and spin-off companies, visitors, students, university employee volunteerism, and alumni, as shown in Table 3.18, broken down by each industry sector's individual impact on the state economy using processes outlined earlier in this chapter. By showing the impact from individual industry sectors, it is possible to see in finer detail the industries that drive the greatest impact on the state economy from VCU's activities and from where the university's alumni are employed. For example, the activities of VCU and the university's alumni in the Health Care & Social Assistance industry sector generated an impact of $2.9 billion in FY 2023-24.

Table 3.18: Total VCU impact by industry, FY 2023-24

Industry sector	Total income (thousands)	Jobs supported
Health Care & Social Assistance	$2,882,007	27,553
Government, Education	$1,243,751	14,454
Professional & Technical Services	$1,003,639	7,870
Government, Non-Education	$654,042	4,273
Other Services (except Public Administration)	$425,497	5,393
Real Estate & Rental & Leasing	$401,126	5,529
Administrative & Waste Services	$319,665	3,687
Finance & Insurance	$306,258	1,835
Retail Trade	$299,215	4,252
Information	$297,249	1,159
Accommodation & Food Services	$219,513	4,539
Manufacturing	$203,574	1,283
Construction	$179,883	1,909
Arts, Entertainment, & Recreation	$162,102	4,822
Management of Companies & Enterprises	$157,389	860
Educational Services	$154,995	3,618
Wholesale Trade	$145,090	691
Transportation & Warehousing	$78,077	1,762
Utilities	$47,987	70
Agriculture, Forestry, Fishing, & Hunting	$6,596	120
Mining, Quarrying, & Oil and Gas Extraction	$5,960	28
Total impact	**$9,193,613**	**95,707**

Source: Lightcast impact model

Chapter 4:

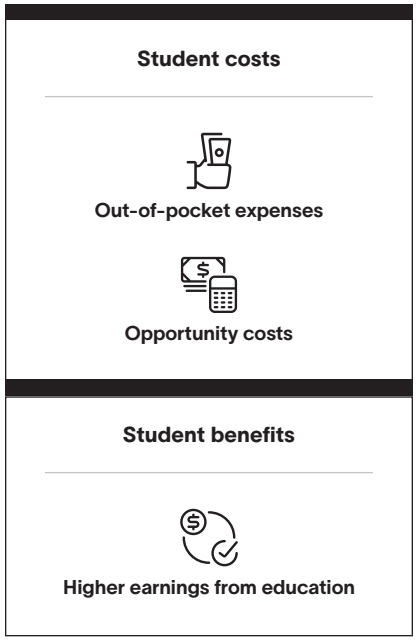
Investment analysis

The benefits generated by VCU affect the lives of many people. The most obvious beneficiaries are the university's students; they give up time and money to go to the university in return for a lifetime of higher wages and improved quality of life. But the benefits do not stop there. As students earn more, communities and citizens throughout Virginia 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 government of Virginia and local government.

Investment analysis is the process of evaluating total costs and measuring these against total benefits to determine whether a proposed venture will be profitable. If benefits outweigh costs, the investment is worthwhile. If costs outweigh benefits, the investment will lose money and is thus considered infeasible. In this chapter, we evaluate VCU as a worthwhile investment from the perspectives of students, taxpayers, and society.

Student perspective

To enroll in postsecondary education, students pay for tuition and forgo monies that otherwise they would have earned had they chosen to work instead of attend college. From the perspective of students, education is the same as an investment. Students incur a cost, or put up a certain amount of money, with the expectation of receiving benefits in return. The total costs consist of the tuition and fees as well as student loan interest that students pay and the opportunity cost of forgone time and money. The benefits are the higher earnings that students receive as a result of their education.



Calculating student costs

Student costs consist of three main items: direct outlays, opportunity costs, and future principal and interest costs incurred from student loans. Direct outlays include tuition and fees, equal to $293.6 million from Figure 2.1. Direct outlays also include the cost of books and supplies. On average, full-time students spent $1,250 each on books and supplies during the reporting year.[29] Multiplying this figure by the number of full-time equivalents (FTEs) produced by the university in FY 2023-24[30] generates a total cost of $32.5 million for books and supplies.

In order to pay the cost of tuition, some students had to take out loans. These students not only incur the cost of tuition from the university but also incur the interest cost of taking out loans. In FY 2023-24, students received a total of $53.9 million in federal loans to attend the university.[31] Students pay back these loans along with interest over the span of several years in the future. Since students pay off these loans over time, they accrue no initial cost during the analysis year. Hence, to avoid double counting, the $53.9 million in federal loans is subtracted from the costs incurred by students in FY 2023-24.

In addition to the cost of tuition, books, and supplies, students also experienced an opportunity cost of attending college during the analysis year. Opportunity cost is the most difficult component of student costs to estimate. It measures the value of time and earnings forgone by students who attend a university 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 university.

29 Based on the data provided by VCU.

30 A single FTE is equal to 30 CHEs for undergraduate students and 24 CHEs for graduate students, so there were 24,337 FTEs produced by students in FY 2023-24, equal to 717,284 CHEs divided by the weighted average number of CHEs per student.

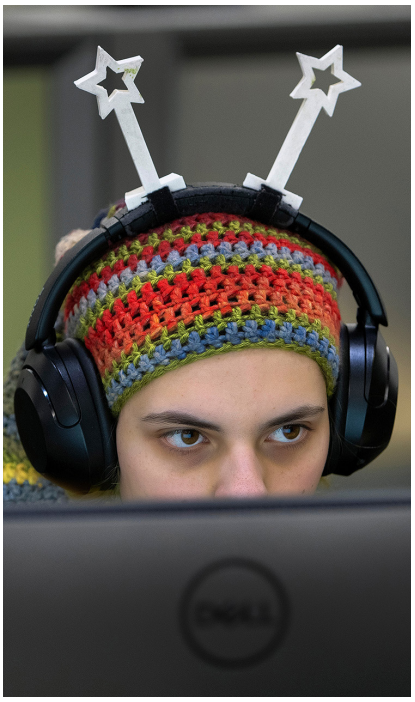
31 Due to data limitations, only federal loans are considered in this analysis.

We derive the students' full earning potential by weighting the average annual earnings levels in Figure 2.4 according to the education level breakdown of the student population at the start of the analysis year.[32] However, the earnings levels in Figure 2.4 reflect what average workers earn at the midpoint of their careers, not while attending the university. Because of this, we adjust the earnings levels to the average age of the student population (24) to better reflect their wages at their current age.[33] This calculation yields an average full earning potential of $21,082 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 the university in FY 2023-24 earned an average of 23.0 CHEs per student (excluding dual credit high school students), which is approximately equal to 83% of a full academic year.[34] We thus include no more than $17,521 (or 83%) 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. It is estimated that 65% of students are employed.[35] For the remainder of students, we assume that they are either seeking work or planning to seek work once they complete their educational goals. By choosing to enroll, therefore, non-working students give up everything that they can potentially earn during the academic year (i.e., the $17,521). The total value of their forgone earnings thus comes to $191.1 million.

Working students are able to maintain all or part of their earnings while enrolled. However, many of them hold jobs that pay less than statistical averages, usually because those are the only jobs they can find that accommodate their course schedule. These jobs tend to be at entry level, such as restaurant servers or cashiers. To account for this, we assume that working students hold jobs that pay 82% of what they would have earned had they chosen to work full-time rather than go to college.[36] The remaining 18% comprises the percentage of their full earning potential that they forgo. Obviously, this assumption varies by person; some students forgo more and others less. Since we do not know the actual jobs that students hold while attending, the 18% in forgone earnings serves as a reasonable average.



32 This is based on students who reported their prior level of education to the university. The prior level of education data was then adjusted to exclude dual credit high school students.

33 Further discussion on this adjustment appears in Appendix 7.

34 Equal to 23.0 CHEs divided by 30 for the proportion of undergraduate students and 24 for the proportion of graduate students, the assumed number of CHEs in a full-time academic year.

35 Lightcast provided an estimate of the percentage of students employed. This estimate, approved for this analysis by the university, is derived from Lightcast's review of data collected across other universities Lightcast has worked with over the years.. This figure excludes dual credit high school students, who are not included in the opportunity cost calculations.

36 The 82% assumption is based on the average hourly wage of jobs commonly held by working students divided by the state average hourly wage. Occupational wage estimates are published by the Bureau of Labor Statistics (see http://www.bls.gov/oes/current/oes_nat.htm).

Class of 2024: Hope Ollivant found artistic expression in many forms: Craft/material studies major blended art, fashion, journalism, and entrepreneurial spirit during her VCU experience.

Hope Ollivant planned to major in fashion, but her journey through VCU's School of the Arts took on a different look during her freshman year.

Her exposure to its metal and ceramics studios, and her enjoyment of the art foundation course, prompted the Northern Virginia native to embrace new interests, particularly jewelry and sculpture and craft. Serving as a VCUarts tour guide that year also gave her plenty of opportunity to imagine the possibilities.

"They have so much equipment," Ollivant said of the metals studios, which also highlighted creativity and personalization. "You get to see all the students' work—and you get a bench your senior year."

Ollivant's craftsmanship, entrepreneurial spirit, and ongoing interest in fashion came together when, on a winter study-abroad trip to the University of the Arts London, she connected with a fashion student there, Clementine Baldo, who included Ollivant's jewelry at the London College of Fashion Graduate showcase during London Fashion Week.

And in February of this year, Ollivant enjoyed her first solo show at The Anderson, the on-campus gallery of VCUarts. From jewelry to digitally fabricated posters, the show featured a range of her art—in medium, style, and size—that collectively conveyed a story.

"It was mostly about connection between family, friends, partners—and also a lot of exaggeration of symbols and icons, exaggerating the inescapable influence of media and pop culture

on our human connection and emotion and culture," Ollivant said, noting that imagery from animation powerhouse "The Simpsons" and its quirky family has a starring role.

Beyond the studio, one constant in Ollivant's VCU experience has been Ink, the student-run digital alternative magazine that highlights art, music, culture, and fashion. She served initially as a stylist, then senior fashion director and, by junior year, editor in chief, a role she retained as a senior.

"It's definitely my favorite thing about going to school here," Ollivant said. "It is a professional learning experience. There's nothing like it. There's nowhere else where I could learn what I'm learning and get the experience that I'm getting on a professional level like this and get to be surrounded by my friends and amazing creatives every single day."

With graduation near, Ollivant now envisions working as a professional stylist or in a fashion environment for a company or magazine, while continuing to create and sell her jewelry and clay art.

"I feel like I found the perfect path for me," Ollivant said of her VCU journey. "If you look, there's all these really niche things you can do to get exactly where you're going. I just worked hard and kept looking for my people, and I found them."

Thus far we have discussed student costs during the analysis year. However, recall that students take out student loans to attend college during the year, which they will have to pay back over time. The amount they will be paying in the future must be a part of their decision to attend the university today. Students who take out loans are not only required to pay back the principal of the loan but to also pay back a certain amount in interest. The first step in calculating students' loan interest cost is to determine the payback time for the loans. The $53.9 million in loans was awarded to 8,224 students, averaging $6,556 per student in the analysis year. However, this figure represents only one year of loans. Because loan payback time is determined by total indebtedness,

we assume that since the university is a four-year university, students will be indebted four times that amount, or $26,225 on average. According to the U.S. Department of Education, this level of indebtedness will take up to 20 years to pay back under the standard repayment plan.[37]

This indebtedness calculation is used solely to estimate the loan payback period. Students will be paying back the principal amount of $53.9 million over time. After taking into consideration the time value of money, this means that students will pay off a discounted present value of $31.5 million in principal over the 20 years. In order to calculate interest, we only consider interest on the federal loans awarded to students in FY 2023-24. Using the student discount rate of 4.9%[38] as our interest rate, we calculate that students will pay a total discounted present value of $21.8 million in interest on student loans throughout the first 20 years of their working lifetime. The stream of these future interest costs together with the stream of loan payments is included in the costs of Column 5 of Table 4.2.

Table 4.1: Present value of student costs, FY 2023-24 (thousands)

Direct outlays in FY 2023-24	
Tuition and fees	$293,641
Less federal loans received	-$53,918
Books and supplies	$32,522
Total direct outlays	**$272,245**
Opportunity costs in FY 2023-24	
Earnings forgone by non-working students	$191,129
Earnings forgone by working students	$63,646
Less residual aid	-$8,955
Total opportunity costs	**$245,820**
Future student loan costs (present value)	
Student loan principal	$31,452
Student loan interest	$21,769
Total present value student loan costs	**$53,221**
Total present value student costs	**$571,286**

Source: Based on data provided by VCU and outputs of the Lightcast impact model

The steps leading up to the calculation of student costs appear in Table 4.1. Direct outlays amount to $272.2 million, the sum of tuition and fees ($293.6 million) and books and supplies ($32.5 million), less federal loans received ($53.9 million). Opportunity costs for working and non-working students amount to $245.8 million, excluding

37 Repayment period based on total education loan indebtedness, U.S. Department of Education, 2022. https://studentaid.ed.gov/sa/repay-loans/understand/plans/standard.

38 The student discount rate is derived from the three-year average of the baseline forecasts for the 10-year discount rate published by the Congressional Budget Office. See the Congressional Budget Office, Student Loan and Pell Grant Programs—May 2023 Baseline. https://www.cbo.gov/data/baseline-projections-selected-programs.

$9.0 million in offsetting residual aid that is paid directly to students.[39] Finally, we have the present value of future student loan costs, amounting to $53.2 million between principal and interest. Summing direct outlays, opportunity costs, and future student loan costs together yields a total of $571.3 million in present value student costs.

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 Figure 2.4, mean earnings levels in Virginia at the midpoint of the average-aged worker's career increase as people achieve higher levels of education. The differences between earnings levels in Virginia define the incremental benefits of moving from one education level to the next.

A key component in determining the value of students' education is the value of their future benefits stream; i.e., what more they can expect to earn as a result of their education. We calculate the future benefits stream to the university's FY 2023-24 students first by determining their average annual increase in earnings, equal to $254.5 million. This value represents the higher wages that accrue to students at the midpoint of their careers and is calculated based on the marginal wage increases of the CHEs that students complete while attending the university. Using the earnings in Virginia, the marginal wage increase per CHE is $355. For a full description of the methodology used to derive the $254.5 million, see Appendix 7.

The second step is to project the $254.5 million annual increase in earnings into the future, for as long as students remain in the workforce. We do this by using the extended Mincer function to predict the change in earnings at each point in an individual's working career.[40] The Mincer function originated from Mincer's seminal work on human capital (1958). The function estimates earnings using an individual's years of education and post-schooling experience. While some have criticized Mincer's earnings function, it is still upheld in recent data and has served as the foundation for a variety of research pertaining to labor economics. Card (1999 and 2001) addresses a number of these criticisms using U.S. based research over the last three decades and concludes that any upward bias in the Mincer parameters is on the order of 10% or less. Thus, to account for any upward bias, we conservatively incorporate a 10% reduction in our projected earnings, otherwise known as the ability bias.

Further, due to inconsistencies in the original quadratic Mincer specification,[41] as noted above, we use an enhanced version of the Mincer function—a quartic specification—that, besides the education level and work experience variables, factors in demographic characteristics such as sex and race/ethnicity to project, as precisely as possible, the

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

40 Appendix 7 provides more information on the Mincer function and how it is used to predict future earnings growth.

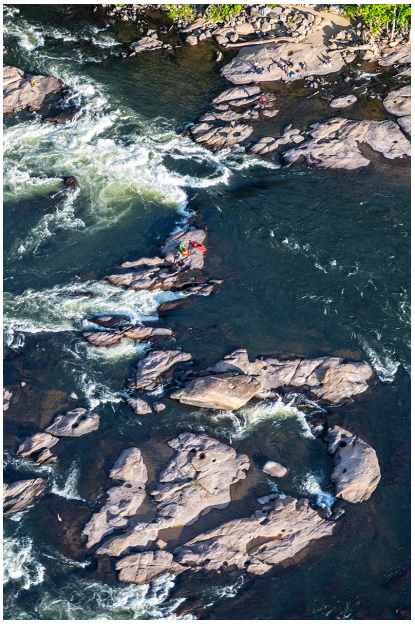
41 Hamlen, S. S., & Hamlen, W. A. (2012). The inconsistency of the quadratic Mincer equation: A proof. *Theoretical Economics Letters*, 2(2), 115-120. https://doi.org/10.4236/tel.2012.22021.

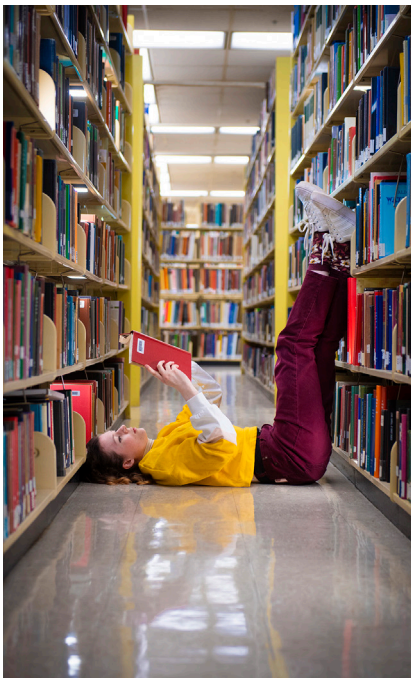
former students' wage trajectories.[42] With the $254.5 million representing the students' higher earnings at the midpoint of their careers, we apply scalars from the Mincer function to yield a stream of projected future benefits that gradually increase from the time students enter the workforce, peak 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 4.2.

As shown in Table 4.2, the $254.5 million in gross higher earnings occurs around Year 14, which is the approximate midpoint of the students' future working careers given the average age of the student population and an assumed retirement age of 67. In accordance with the Mincer function, the gross higher earnings that accrue to students in the years leading up to the midpoint are less than $254.5 million and the gross higher earnings in the years after the midpoint are greater than $254.5 million.

The final step in calculating the students' future benefits stream is to net out the potential benefits generated by students who are either not yet active in the workforce or who leave the workforce over time. This adjustment appears in Column 3 of Table 4.2 and represents the percentage of the FY 2023-24 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 university or because they are unable to find a job immediately upon graduation. Accordingly, we apply a set of "settling-in" factors to account for the time needed by students to find employment and settle into their careers. As discussed in Chapter 3, settling-in factors delay the onset of the benefits by one to three years for students who graduate with a certificate or a degree and by one to five years for degree-seeking students who do not complete during the analysis year.

Beyond the first five years of the time horizon, students will leave the workforce for any number of reasons, whether death, retirement, or unemployment. We estimate the rate of attrition using the same data and assumptions applied in the calculation of the attrition rate in the economic impact analysis of Chapter 3.[43] 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 4.2 shows the net higher earnings to students after accounting for both the settling-in patterns and attrition.





42 Murphy, K. M., & Welch, F. (1990). Empirical age-earnings-profiles. *Journal of Labor Economics*, 8(2), 202-229.

43 See the discussion of the alumni impact in Chapter 3. 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.

Table 4.2: **Projected benefits and costs, student perspective**

1	2	3	4	5	6
Year	Gross higher earnings to students (millions)	% active in workforce*	Net higher earnings to students (millions)	Student costs (millions)	Net cash flow (millions)
0	$101.6	11%	$11.4	$518.1	-$506.7
1	$112.2	21%	$23.4	$4.2	$19.2
2	$123.1	31%	$37.6	$4.2	$33.3
3	$134.2	47%	$62.9	$4.2	$58.7
4	$145.6	70%	$101.3	$4.2	$97.1
5	$157.1	97%	$152.2	$4.2	$148.0
6	$168.7	97%	$163.2	$4.2	$159.0
7	$180.3	97%	$174.1	$4.2	$169.9
8	$191.7	96%	$184.9	$4.2	$180.6
9	$203.0	96%	$195.4	$4.2	$191.2
10	$214.0	96%	$205.6	$4.2	$201.4
11	$224.7	96%	$215.5	$4.2	$211.3
12	$235.1	96%	$225.0	$4.2	$220.7
13	$245.0	95%	$234.0	$4.2	$229.7
14	$254.5	95%	$242.4	$4.2	$238.2
15	$263.4	95%	$250.3	$4.2	$246.1
16	$271.8	95%	$257.6	$4.2	$253.4
17	$279.6	95%	$264.2	$4.2	$260.0
18	$286.8	94%	$270.2	$4.2	$266.0
19	$293.4	94%	$275.5	$4.2	$271.3
20	$299.3	94%	$280.1	$4.2	$275.9
21	$304.5	93%	$284.0	$0.0	$284.0
22	$309.1	93%	$287.2	$0.0	$287.2
23	$313.1	93%	$289.7	$0.0	$289.7
24	$316.4	92%	$291.5	$0.0	$291.5
25	$319.1	92%	$292.6	$0.0	$292.6
26	$321.2	91%	$293.0	$0.0	$293.0
27	$322.7	91%	$292.8	$0.0	$292.8
28	$323.7	90%	$291.9	$0.0	$291.9
29	$324.0	90%	$290.3	$0.0	$290.3
30	$323.9	89%	$288.2	$0.0	$288.2
31	$323.3	88%	$285.4	$0.0	$285.4
32	$322.2	88%	$282.1	$0.0	$282.1
33	$320.7	87%	$278.3	$0.0	$278.3
34	$318.8	86%	$274.0	$0.0	$274.0
35	$316.5	85%	$269.2	$0.0	$269.2
36	$313.9	84%	$263.9	$0.0	$263.9
37	$310.9	83%	$258.3	$0.0	$258.3
38	$307.7	82%	$252.3	$0.0	$252.3
39	$304.2	81%	$246.0	$0.0	$246.0
40	$300.5	80%	$239.4	$0.0	$239.4
41	$296.6	78%	$232.6	$0.0	$232.6
42	$292.5	77%	$225.6	$0.0	$225.6
Present value			**$3,584.2**	**$571.3**	**$3,012.9**

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

Source: Lightcast impact model

Benefit-cost ratio	Internal rate of return	Payback period (years)
6.3	22.0%	5.9

Benefit-cost comparison for 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 4.9% (see below). Because students tend to rely upon debt to pay for education—i.e. they are negative savers—their discount rate is based upon student loan interest rates.[44] In Appendix 2, we conduct a sensitivity analysis of this discount rate. The present value of the benefits is then compared to student costs to derive the investment analysis results, expressed in terms of a benefit-cost ratio, rate of return, and payback period. The investment is feasible if returns match or exceed the minimum threshold values; i.e., a benefit-cost ratio greater than 1.0, a rate of return that exceeds the discount rate, and a reasonably short payback period.

Discount rate

The discount rate is a rate of interest that converts future costs and benefits to present values. For example, $1,000 in higher earnings realized 30 years in the future is worth much less than $1,000 in the present. All future values must therefore be expressed in present value terms in order to compare them with investments (i.e., costs) made today. The selection of an appropriate discount rate, however, can become an arbitrary and controversial undertaking. As suggested in economic theory, the discount rate should reflect the investor's opportunity cost of capital, i.e., the rate of return one could reasonably expect to obtain from alternative investment schemes. In this study we assume a 4.9% discount rate from the student perspective and a 0.7% discount rate from the perspectives of taxpayers and society.

In Table 4.2, the net higher earnings of students yield a cumulative discounted sum of approximately $3.6 billion, the present value of all of the future earnings increments (see the bottom section of Column 4). This may also be interpreted as the gross capital asset value of the students' higher earnings stream. In effect, the aggregate FY 2023-24 student body is rewarded for its investment in the university with a capital asset valued at $3.6 billion.

The students' cost of attending the university is shown in Column 5 of Table 4.2, equal to a present value of $571.3 million. Comparing the cost with the present value of benefits yields a student benefit-cost ratio of 6.3 (equal to $3.6 billion in benefits divided by $571.3 million in costs).

Another way to compare the same benefits stream and associated cost is to compute the rate of return. The rate of return indicates the interest rate that a bank would have to pay a depositor to yield an equally attractive stream of future payments.[45]

44 The student discount rate is derived from the most recent three-year average baseline forecasts for the 10-year Treasury rate published by the Congressional Budget Office. See the Congressional Budget Office, Student Loan and Pell Grant Programs—May 2023 Baseline. https://www.cbo.gov/data/baseline-projections-selected-programs.

45 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.

Medicines for All Institute (M4ALL)

The Medicines for All Institute (M4ALL) at VCU's College of Engineering is advancing global access to lifesaving medicines while training the next generation of chemists and engineers. M4ALL integrates innovative modeling principles with applied research to develop affordable, high-quality medicines while also giving graduate students a hands-on approach which enriches student learning and fosters strong engagement, as students contribute to real-world global health solutions.

Founded in 2017 by B. Frank Gupton, Chair of the Department of Chemical and Life Science Engineering, and supported by the Bill & Melinda Gates Foundation, M4ALL empowers students to design pharmaceutical processes that have immediate global impact. The institute partners with research institutes and manufacturers worldwide to train scientists in producing medicines locally. This reduces reliance on a limited number of global manufacturers and promotes self-sufficiency in healthcare for underserved regions.

M4ALL employs innovative drug synthesis and manufacturing methods that lower production costs and minimize waste, improving pharmaceutical accessibility worldwide. Its focus on applied learning spans from laboratory experiments to large-scale implementation. Graduate researchers work closely with manufacturing partners in Africa, India, and the Caribbean, gaining valuable skills in cross-cultural collaboration, international project management, and building professional networks across academia, NGOs, and industry.

M4ALL's work aligns with numerous graduate programs focused on engineering, health, and pharmaceutical science and collaborates with various VCU masters and PhD programs based on individual student's interests. While M4ALL operates under the auspices of the VCU College of Engineering, M4ALL has partnered with VCU's Chemistry Department and School of Pharmacy to advance the state of pharmaceutical engineering. The institute's multidisciplinary educational model underscores innovation: its flagship Pharmaceutical Engineering Ph.D., launched in 2019, unites the School of Pharmacy and College of Engineering to bridge chemistry, formulation science, continuous manufacturing, and nanomaterials. This cross-departmental Ph.D. trains professionals who can navigate the entire drug development pipeline—a unique asset in both industry and academic leadership.

The institute's success has spurred new partnerships with manufacturers and nonprofits, creating pipelines for internships, collaborative projects, and career opportunities. M4ALL embodies VCU's mission to educate leaders who transform health and communities through experiential learning, multidisciplinary innovation, workforce alignment, and dedicated service to society.

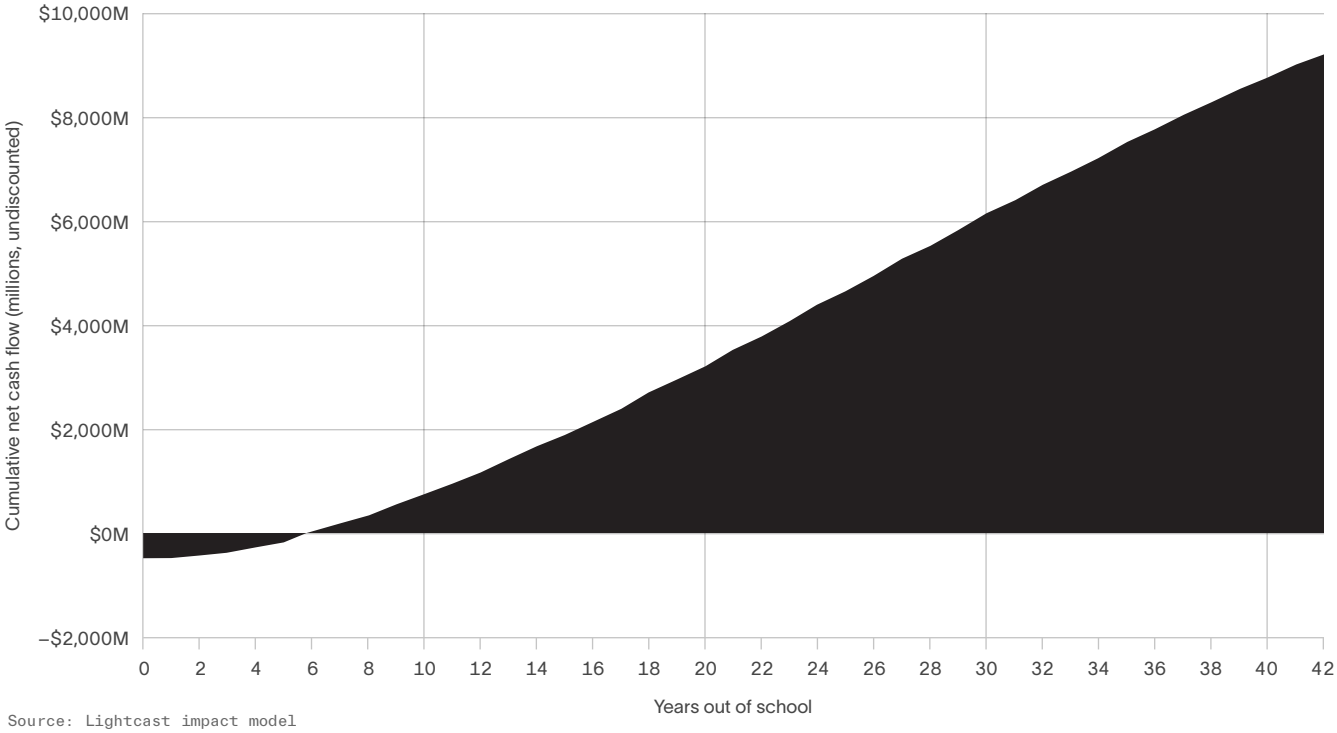
Table 4.2 shows students of the university earning average returns of 22.0% on their investment of time and money. This is a favorable return compared, for example, to approximately 1% on a standard bank savings account, or 10.1% on stocks and bonds (30-year average return).

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, the 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 4.2, the 22.0% student rate of return is a real rate. With an inflation rate of 2.6% (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 24.6%, higher than what is reported in Table 4.2.

University students see an average rate of return of **22.0%** for their investment of time and money.

The payback period is defined as the length of time it takes to entirely recoup the initial investment.[46] Beyond that point, returns are what economists would call pure costless rent. As indicated in Table 4.2, students at the university see, on average, a payback period of 5.9 years, meaning 5.9 years after their initial investment of forgone earnings and out-of-pocket costs, they will have received enough higher future earnings to fully recover those costs (Figure 4.1).

Figure 4.1: Student payback period

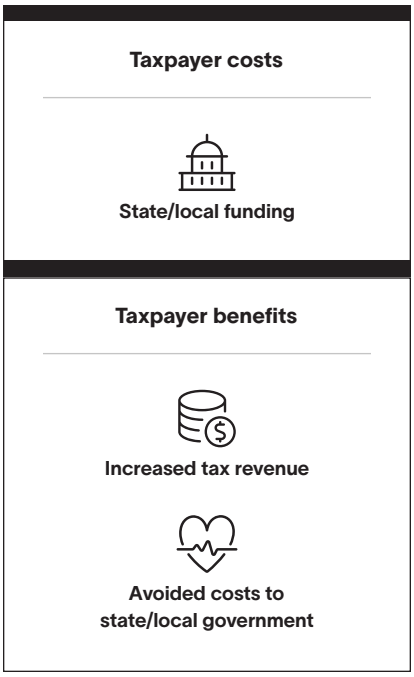


Source: Lightcast impact model

46 Payback analysis is generally used by the business community to rank alternative investments when safety of investments is an issue. Its greatest drawback is it does not account for 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 account for student living expenses.

Taxpayer perspective

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



Growth in tax revenues for Virginia

As a result of their time at the university, students earn more because of the skills they learned while attending the university, and businesses earn more because student skills make capital more productive (buildings, machinery, and everything else). This in turn raises profits and other business property income. Together, increases in labor and non-labor (i.e., capital) income are considered the effect of a skilled workforce. These in turn increase tax revenues since the government of Virginia and local government is able to apply tax rates to higher earnings.

Estimating the effect of the university on increased tax revenues begins with the present value of the students' future earnings stream, which is displayed in Column 4 of Table 4.2. To these net higher earnings, we apply a multiplier derived from Lightcast's MR-SAM model to estimate the added labor income created in the Commonwealth as students and businesses spend their higher earnings.[47] 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 Virginia gross state product to total labor income in the Commonwealth. We also include the spending impacts discussed in Chapter 3 that were created in FY 2023-24 from operations, construction, VCU Health System, research, visitor, and student spending. To each of these, we apply the prevailing tax rates so we capture only the tax revenues attributable to the government of Virginia and local government from this additional revenue.

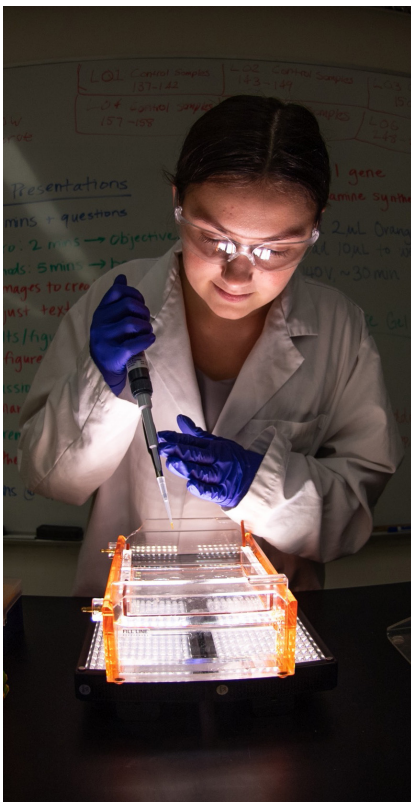
Not all of these tax revenues may be counted as benefits to the Commonwealth, however. Some students leave Virginia during the course of their careers, and the higher earnings they receive as a result of their education leave Virginia with them. To account for this dynamic, we combine the university's student settlement estimates from Lightcast professional profiles data with data on migration patterns from the Internal Revenue Service to estimate the number of students who will leave Virginia's workforce over time.

47 For a full description of the Lightcast MR-SAM model, see Appendix 6.

We apply another reduction factor to account for the students' alternative education opportunities. This is the same adjustment that we use in the calculation of the alumni impact in Chapter 3 and is designed to account for the counterfactual scenario where the university does not exist. The assumption in this case is that any benefits generated by students who could have received an education even without the university 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 university would have generated benefits anyway even without the university. For more information on the alternative education variable, see Appendix 8.

We apply a final adjustment factor to account for the "shutdown point" that nets out benefits that are not directly linked to the government of Virginia and local government costs of supporting VCU. As with the alternative education variable discussed under the alumni impact, the purpose of this adjustment is to account for counterfactual scenarios. In this case, the counterfactual scenario is where the government of Virginia and local government funding for the university did not exist and the university had to derive the revenue elsewhere. To estimate this shutdown point, we apply a sub-model that simulates the students' demand curve for education by reducing support from the government of Virginia and local government to zero and progressively increasing student tuition and fees. As student tuition and fees increase, enrollment declines. For the university, the shutdown point adjustment is 0%, meaning that the university could not operate without taxpayer support. As such, no reduction applies. For more information on the theory and methodology behind the estimation of the shutdown point, see Appendix 10.

After adjusting for attrition, alternative education opportunities, and the shutdown point, we calculate the present value of the future added tax revenues that occur in the Commonwealth, equal to $1.1 billion. Recall from the discussion of the student investment analysis that the present value represents the sum of the future benefits that accrue each year over the course of the time horizon, discounted to current year dollars to account for the time value of money. Given that the stakeholder in this case is the public sector, we use the discount rate of 0.7%. This is the three-year average of the real Treasury interest rate reported by the Office of Management and Budget (OMB) for 30-year investments, and in Appendix 2, we conduct a sensitivity analysis of this discount rate.[48]



Government savings

In addition to the creation of higher tax revenues to the government of Virginia and local government, education is statistically associated with a variety of lifestyle changes that generate social savings, also known as external or incidental benefits of education. These represent the avoided costs to the government that otherwise would have been drawn from public resources absent the education provided by the university.

48 Office of Management and Budget. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Revised February 17, 2023. Accessed March 2024. https://www.whitehouse.gov/wp-content/uploads/2023/02/M-23-12-Appendix-C-Update_Discount-Rates.pdf

Government savings appear in Figure 4.2 and Table 4.3 and break down into three main categories: 1) health savings, 2) crime savings, and 3) income assistance savings. Health savings include avoided medical costs that would have otherwise been covered by the government of Virginia and local government. Crime savings consist of avoided costs to the justice system (i.e., police protection, judicial and legal, and corrections). Income assistance benefits comprise avoided costs due to the reduced number of welfare and unemployment insurance claims.

The model quantifies government savings by calculating the probability at each education level that individuals will have poor health, commit crimes, or claim welfare and unemployment benefits. Deriving the probabilities involves assembling data from a variety of studies and surveys analyzing the correlation between education and health, crime, and income assistance at the national level as well as in Virginia. 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 university, will not have poor health, commit crimes, or demand income assistance. We dampen these results by the ability bias adjustment discussed earlier in the student perspective section and in Appendix 7 to account for factors (besides education) that influence individual behavior. We then multiply the marginal effects of education by the associated costs of health, crime, and income assistance.[49] Finally, we apply the same adjustments for attrition, alternative education, and the shutdown point to derive the net savings to the government. Total government savings appear in Figure 4.2 and sum to $129.8 million.

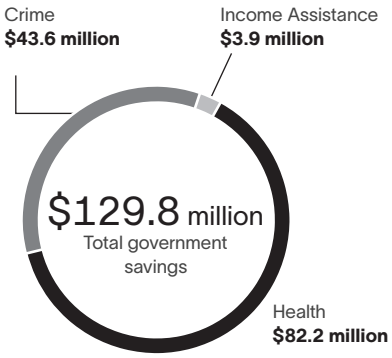
In addition to the creation of **higher tax revenues** to the government of Virginia and local government, education is statistically associated with a variety of lifestyle changes that generate **social savings**.

Table 4.3: Present value of added tax revenue and government savings (thousands)

Added tax revenue	**$1,111,901**
Government savings	
Health-related savings	$82,237
Crime-related savings	$43,634
Income assistance savings	$3,894
Total government savings	**$129,765**
Total taxpayer benefits	**$1,241,666**

Source: Lightcast impact model

Figure 4.2: Present value of government savings



Source: Lightcast impact model

Table 4.3 displays all benefits to taxpayers. The first row shows the added tax revenues created in Virginia, equal to $1.1 billion, from students' higher earnings, increases in non-labor income, and spending impacts. The sum of the government savings and the added income in the Commonwealth is $1.2 billion, as shown in the bottom row of Table 4.3. These savings continue to accrue in the future as long as the FY 2023-24 student population of the university remains in the workforce.

49 For a full list of the data sources used to calculate the social externalities, see the Resources and References section. See also Appendix 11 for a more in-depth description of the methodology.

Benefit-cost comparison for taxpayers

Taxpayer costs are reported in Table 4.4 and come to $615.7 million, equal to the contribution of the government of Virginia and local government to VCU. In return for their public support, taxpayers are rewarded with an investment benefit-cost ratio of 2.0 (= $1.2 billion ÷ $615.7 million), indicating a profitable investment.

At 11.5%, the rate of return to taxpayers in Virginia for VCU funding from the Commonwealth and local government is favorable. Given that the stakeholder in this case is the public sector, we use the mentioned earlier discount rate of 0.7%, the three-year average of the real Treasury interest rate reported by the Office of Management and Budget for 30-year investments. 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 0.7% would mean that VCU just pays its own way. In principle, governments could borrow monies used to support VCU and repay the loans out of the resulting added taxes and reduced government expenditures. A rate of return of 11.5%, on the other hand, means that VCU not only pays its own way but also generates a surplus that the government of Virginia and local government can use to fund other programs.

Additionally, a benefit-cost ratio greater than 1.0 indicates a good public investment since the taxes from the university's student higher earnings and reduced government expenditures not only recover taxpayer costs but also grow the Virginia tax base.

A benefit-cost ratio of **2.0** means VCU is a good public investment since the taxes from the university's student higher earnings and reduced government expenditures not only recover taxpayer costs but also grow the Virginia tax base.

Write Your Way Out

Write Your Way Out, a partnership between VCU's College of Humanities and Sciences and the Richmond Commonwealth Attorney, is a criminal justice diversion. Instead of going to the Richmond City Jail, low-level offenders come to VCU to write their way out of the lives that led to their arrests. The Richmond Commonwealth Attorney's Office selects low-level offenders to participate in the program who pose no threat to public safety. Instead of jail time, they sign a plea agreement to take English 366: Writing and Social Change, taught by Dr. David Coogan. With VCU students, these participants read Writing Our Way Out: Memoirs from Jail and write a 30-page memoir based on the same prompts the authors used. If diverted participants complete the course, their charges are cleared. They receive no criminal record and no jail time.

The partnership has enabled low-level offenders to avoid jail, remain with their families, keep their jobs, keep government benefits, and, through the writing and sharing process, get the support they need to redirect their lives to avoid future charges. Since the program's launch in 2018, Dr. Coogan has taught the course four times, enabling thirty people to avoid jail. Only three have re-offended.

In class, interaction-diverted participants and VCU students share their life stories together and collectively search for insight, healing, and closure. Students rate the course highly on evaluations (between a 4.7 and a perfect 5). They testify that they learned valuable lessons about shared humanity and vulnerability before traumatic incidents and appreciate seeing the struggle for understanding and healing unfolding across a diverse group. They are also proud to be a part of a program at VCU that intervenes practically in the criminal justice system, opening up a space for rehabilitative work.

Table 4.4: **Projected benefits and costs, taxpayer perspective**

1	2	3	4
Year	Benefits to taxpayers (millions)	State & local government costs (millions)	Net cash flow (millions)
0	$449.0	$615.7	-$166.7
1	$4.4	$0.0	$4.4
2	$6.5	$0.0	$6.5
3	$10.6	$0.0	$10.6
4	$16.4	$0.0	$16.4
5	$23.6	$0.0	$23.6
6	$24.0	$0.0	$24.0
7	$24.4	$0.0	$24.4
8	$24.9	$0.0	$24.9
9	$25.3	$0.0	$25.3
10	$25.7	$0.0	$25.7
11	$26.0	$0.0	$26.0
12	$26.2	$0.0	$26.2
13	$26.4	$0.0	$26.4
14	$26.6	$0.0	$26.6
15	$26.6	$0.0	$26.6
16	$26.7	$0.0	$26.7
17	$26.7	$0.0	$26.7
18	$26.6	$0.0	$26.6
19	$26.5	$0.0	$26.5
20	$26.4	$0.0	$26.4
21	$26.2	$0.0	$26.2
22	$25.9	$0.0	$25.9
23	$25.6	$0.0	$25.6
24	$25.3	$0.0	$25.3
25	$25.0	$0.0	$25.0
26	$24.6	$0.0	$24.6
27	$24.1	$0.0	$24.1
28	$23.7	$0.0	$23.7
29	$23.2	$0.0	$23.2
30	$22.7	$0.0	$22.7
31	$22.2	$0.0	$22.2
32	$21.6	$0.0	$21.6
33	$21.1	$0.0	$21.1
34	$20.5	$0.0	$20.5
35	$19.9	$0.0	$19.9
36	$19.3	$0.0	$19.3
37	$18.7	$0.0	$18.7
38	$18.0	$0.0	$18.0
39	$17.4	$0.0	$17.4
40	$16.8	$0.0	$16.8
41	$16.1	$0.0	$16.1
42	$15.5	$0.0	$15.5
Present value	**$1,241.7**	**$615.7**	**$626.0**

Source: Lightcast impact model

Benefit-cost ratio	Internal rate of return	Payback period (years)
2.0	11.5%	9.3

Social perspective

Virginia benefits from the education that the university provides through the earnings that students create in the Commonwealth 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 otherwise would have enjoyed if VCU did not exist. Society's investment in VCU stretches across a number of investor groups, from students to employers to taxpayers. We weigh the benefits generated by VCU to these investor groups against the total social costs of generating those benefits. The total social costs include all VCU expenditures, all student expenditures (including interest on student loans) less tuition and fees, and all student opportunity costs, totaling a present value of $1.6 billion.

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

Social costs

VCU expenditures

Student out-of-pocket expenses

Student opportunity costs

Social benefits

Increased economic base

Avoided social costs

Growth in Virginia's economic base

In the process of absorbing the newly acquired skills of students who attend the university, not only does the productivity of the Virginia workforce increase, but so does the productivity of its physical capital and assorted infrastructure. Students earn more because of the skills they learned while attending the university, 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.

Estimating the effect of VCU on Virginia's economic base follows a similar process used when calculating increased tax revenues in the taxpayer perspective. However, instead of looking at just the tax revenue portion, we include all of the added earnings and business output. First, we calculate the students' future higher earnings stream. We factor in student attrition and alternative education opportunities to arrive at net higher earnings. We again apply multipliers derived from Lightcast's MR-SAM model to estimate the added labor and non-labor income created in the Commonwealth as students and businesses spend their higher earnings and as businesses generate additional profits from this increased output (added student and business income in Figure 4.3). We also include the university operations, construction, VCU Health System

operations, research, visitor, and student spending impacts discussed in Chapter 3 that were created in FY 2023-24 (added income from VCU activities in Figure 4.3). The shutdown point does not apply to the growth of the economic base because the social perspective captures not only taxpayer support in Virginia and local taxpayer support to VCU, but also the support from the students and other non-government sources.

Using this process, we calculate the present value of the future added income that occurs in the Commonwealth, equal to $12.3 billion. Recall from the discussion of the student and taxpayer investment analyses 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. As stated in the taxpayer perspective, given that the stakeholder in this case is the public sector, we use the discount rate of 0.7%.

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 activities that produce positive externalities, such as beekeeping.

Educational institutions are like beekeepers. While their principal aim is to provide education and raise people's earnings, in the process they create an array of external benefits. Students' health and lifestyles are improved, and society indirectly benefits just as orchard owners indirectly benefit from beekeepers. In an effort to provide a more comprehensive report of the benefits generated by education, the model accounts for many of these external social benefits.

Social savings

Similar to the government savings discussed above, society as a whole sees savings due to external or incidental benefits of education. These represent the avoided costs that otherwise would have been drawn from private and public resources absent the education provided by the university. Social benefits appear in Table 4.5 and break down into three main categories: 1) health savings, 2) crime savings, and 3) income assistance savings. These are similar to the categories from the taxpayer perspective above, although health savings now also include lost productivity and other effects associated with smoking, obesity, depression, and substance abuse. In addition to avoided costs to the justice system, crime savings also consist of avoided victim costs and benefits stemming from the added productivity of individuals who otherwise would have been incarcerated. Income assistance savings comprise the avoided government costs due to the reduced number of welfare and unemployment insurance claims.

The Partnership for People with Disabilities

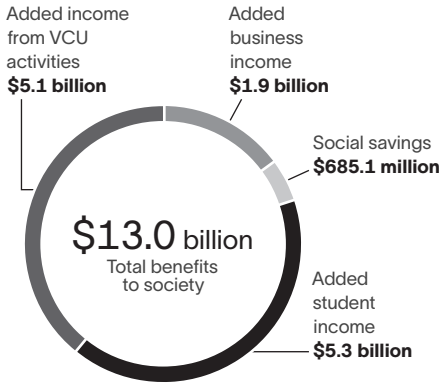
The Partnership for People with Disabilities (Partnership), a university-level research center at VCU, continues to conduct translational research and innovation that directly addresses regional and statewide challenges across health, education, early childhood, and community living systems, improving outcomes for people with intellectual and developmental disabilities (IDD), their families, and the professionals who support them. The Partnership secured and managed more than $14.6 million in grant and contract funding in FY 2025, implementing over 40 projects that directly impacted thousands of Virginians with disabilities and their families. These externally funded initiatives, backed by federal agencies, state partners, and national philanthropic organizations, translated research into meaningful change across the Commonwealth. For example, through a $3.3 million portfolio in community living grants, the Partnership led statewide efforts to support inclusive employment, engaging five Richmond high schools in a photovoice-based work research demonstration initiative. This initiative resulted in 100% of participating students accessing high-quality work-based learning, and several students achieved competitive employment. In addition, Medicaid-funded training projects reached over 2,700 hospital and public health staff, ensuring informed, person-centered services for people with disabilities navigating long-term care systems. Through a strong presence across Virginia, the Partnership also plays a pivotal role in shaping service systems, most notably by partnering with the Department of Behavioral Health and Developmental Services' Regional Quality Councils to turn data into action. These collaborations help regions use real-time insights to drive quality improvement, strengthen accountability, and advance person-centered practices in IDD services across the Commonwealth.

These investments also address system transformation. Through a $2.1 million early childhood grant portfolio, the Partnership delivered professional development and reflective supervision to hundreds of early childhood professionals and partnered with families to inform state-level developmental screening practices. Health-focused projects, totaling nearly $1 million, supported people with IDD as co-researchers in studies addressing mental health, abuse prevention, and healthcare navigation. Families were engaged in funded efforts to improve service access, and over 605 families statewide received direct, funded 1:1 support. With every funded initiative, the Partnership elevates VCU's role as an anchor institution, driving innovation, building regional capacity, and advancing inclusive practices that have real impact in homes, schools, healthcare settings, and communities across Virginia.

Table 4.5 displays the results of the analysis. The first row shows the increased economic base in the Commonwealth, equal to $12.3 billion, from students' higher earnings and their multiplier effects, increases in non-labor income, and spending impacts. Social savings appear next, beginning with a breakdown of savings related to health. These include 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. These savings amount to $632.7 million. Crime savings amount to $48.5 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 income assistance amounts to $3.9 million, stemming from a reduced number of persons in need of welfare or unemployment benefits. All told, social savings amounted to $685.1 million in benefits to communities and citizens in Virginia.

The sum of the social savings and the increased economic base in Virginia is $13.0 billion, as shown in the bottom row of Table 4.5 and in Figure 4.3. These savings accrue in the future as long as the FY 2023-24 student population of the university remains in the workforce.

Figure 4.3: Present value of benefits to society



Source: Lightcast impact model

Table 4.5: Present value of the future increased economic base and social savings in Virginia (thousands)

Increased economic base	**$12,277,961**
Social savings	
Health	
Smoking	$216,813
Obesity	$90,110
Depression	$146,245
Substance abuse	$179,576
Total health savings	**$632,745**
Crime	
Criminal justice system savings	$43,213
Crime victim savings	$982
Added productivity	$4,283
Total crime savings	**$48,477**
Income assistance	
Welfare savings	$3,141
Unemployment savings	$752
Total income assistance savings	**$3,894**
Total social savings	**$685,116**
Total, increased economic base + social savings	**$12,963,077**

Source: Lightcast impact model

Benefit-cost comparison for society

Table 4.6 presents the stream of benefits accruing to the Virginia society and the total social costs of generating those benefits. Comparing the present value of the benefits and the social costs, we have a benefit-cost ratio of 7.9. This means that for every dollar invested in VCU, whether it is the money spent on operations of the university or money spent by students on tuition and fees, an average of $7.90 in benefits will accrue to society in Virginia.[50]

With and without social savings

Earlier in this chapter, social benefits attributable to education (improved health, reduced crime, and reduced demand for income assistance) were defined as externalities that are incidental to the operations of the university. 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 earnings) should be counted. Table 4.4 and Table 4.6 are inclusive of social savings reported as attributable to the university. Recognizing the other point of view, Table 4.7 shows rates of return for both the taxpayer and social perspectives exclusive of social savings. As indicated, returns are still above threshold levels (a net present value greater than zero and a benefit-cost ratio greater than 1.0), confirming that taxpayers and society as a whole receive value from investing in VCU.

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

Table 4.7: Taxpayer and social perspectives with and without social savings

	Including social savings	Excluding social savings
Taxpayer perspective		
Net present value (millions)	$626.0	$496.2
Benefit-cost ratio	2.0	1.8
Internal rate of return	11.5%	9.4%
Payback period (no. of years)	9.3	12.1
Social perspective		
Net present value (millions)	$11,328	$10,643
Benefit-cost ratio	7.9	7.5

Source: Lightcast impact model

Richmond Cemetery Collaboratory

The Richmond Cemetery Collaboratory's mission is to unite faculty, staff, students, organizations, and community partners in Richmond, Virginia, to document and support African American history and culture via the region's cemeteries. The Collaboratory aims to produce place-based knowledge contributing to a community dialogue about caring for our collective past. Its work seeks to restore the commemorative functions of historic African American cemeteries and to recognize the stories of the people buried therein. The project's goal is for its work to inspire future collaborations toward these ends.

The Collaboratory started in 2017 as a learning community among faculty from multiple disciplines from the University of Richmond and VCU and members of the Friends of the East End. Since then, it has expanded to include the Descendants Council of Greater Richmond, the Woodland Restoration foundations and, at various times, Oakwood Arts, the Star of Benevolence Society, and the City of Richmond's Department of Parks, Recreation, and Community Facilities.

The Collaboratory exemplifies how university-community partnerships can leverage the strengths of each other for mutual benefit. One example is the GPS mapping which is done through partnerships at the request of the cemeteries. VCU provides technology and analysis, which the community does not have access to. The university drones account for depressions that people on the ground cannot see and find. Through analysis of the drone imaging, new tombstones and burial sites were found. Community partners provide expertise in ground-truthing and knowledge of the space on the ground. By merging university resources and expertise (drone/GPS) with the ground-truthing of community partners, the cemetery spaces are co-constructed.

This data also puts communities in a better position to request resources and assists partners in communicating with descendants to discuss progress on restoration, next steps, and timelines. The work and research are disseminated in two ways. Faculty use the work to publish, and community partners use it to work with communities and advocates.

The results are tangible, including:

- Creation of digital archives for public use, with a separate portal for the East End to respect the request of the Friends of the East End (community partner), as it was the first cemetery for the partnership. New resources are identified and added annually (e.g., story maps).
- Creation of interactive digital maps of the cemeteries powered by GIS technologies, including 3-D scans of the tombstones so descendants can find their family members.
- Uncovering long-lost tombstones and cemetery sections with drone technology.
- Service Clean-up days.
- Public symposiums and co-convenings to share data, resources, and the archives in other ways.

Table 4.6: **Projected benefits and costs, social perspective**

1	2	3	4
Year	Benefits to society (millions)	Social costs (millions)	Net cash flow (millions)
0	$5,086.1	$1,556.3	$3,529.9
1	$41.5	$4.2	$37.2
2	$62.0	$4.2	$57.8
3	$101.0	$4.2	$96.8
4	$157.6	$4.2	$153.4
5	$227.6	$4.2	$223.4
6	$232.7	$4.2	$228.4
7	$237.8	$4.2	$233.6
8	$243.1	$4.2	$238.8
9	$248.2	$4.2	$244.0
10	$253.1	$4.2	$248.9
11	$256.6	$4.2	$252.4
12	$259.6	$4.2	$255.4
13	$262.0	$4.2	$257.8
14	$263.9	$4.2	$259.7
15	$265.2	$4.2	$261.0
16	$266.0	$4.2	$261.8
17	$266.3	$4.2	$262.0
18	$266.0	$4.2	$261.8
19	$265.2	$4.2	$261.0
20	$263.9	$4.2	$259.7
21	$262.1	$0.0	$262.1
22	$259.9	$0.0	$259.9
23	$257.2	$0.0	$257.2
24	$254.1	$0.0	$254.1
25	$250.6	$0.0	$250.6
26	$246.8	$0.0	$246.8
27	$242.6	$0.0	$242.6
28	$238.1	$0.0	$238.1
29	$233.3	$0.0	$233.3
30	$228.2	$0.0	$228.2
31	$222.9	$0.0	$222.9
32	$217.4	$0.0	$217.4
33	$211.6	$0.0	$211.6
34	$205.7	$0.0	$205.7
35	$199.6	$0.0	$199.6
36	$193.4	$0.0	$193.4
37	$187.1	$0.0	$187.1
38	$180.8	$0.0	$180.8
39	$174.4	$0.0	$174.4
40	$168.0	$0.0	$168.0
41	$161.6	$0.0	$161.6
42	$155.2	$0.0	$155.2
Present value	**$12,963.1**	**$1,634.6**	**$11,328.5**

Source: Lightcast impact model

Benefit-cost ratio
7.9

Payback period (years)
n/a

Chapter 5:

Conclusion

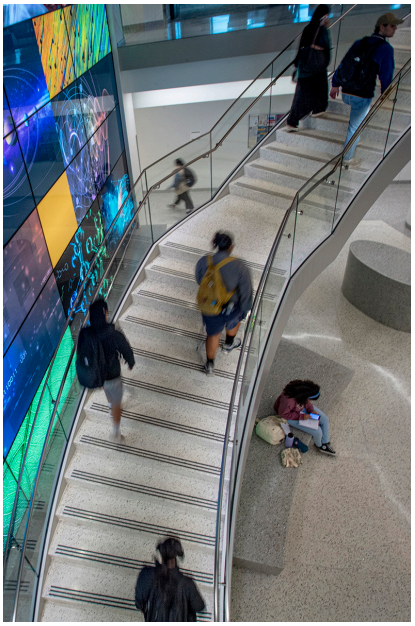
WHILE VCU ADDS VALUE to Virginia beyond the economic impact outlined in this study, the value of VCU's impact in terms of dollars and cents is an important component of VCU's value as a whole. In order to fully assess VCU's value to the state economy, this report has evaluated VCU from the perspectives of economic impact analysis and investment analysis.

From an economic impact perspective, we calculated that VCU generates a total economic impact of **$9.2 billion** in total added income for the state economy. This represents the sum of several different impacts, including:

- University operations spending impact ($463.8 million);
- University construction spending impact ($20.7 million);
- Health system spending impact ($4.0 billion);
- University research spending impact ($416.3 million);
- Start-up and spin-off company impact ($37.1 million);
- Visitor spending impact ($5.4 million);
- Student spending impact ($151.7 million);
- University employee volunteerism impact ($599.8 thousand); and
- Alumni impact ($4.1 billion).

One out of every 61 jobs in Virginia is supported by the activities of VCU and its students.

The total impact of $9.2 billion is equivalent to approximately **1.4%** of the total GSP of Virginia and is equivalent to supporting **95,707 jobs**. For perspective, this means that **one out of every 61 jobs** in Virginia is supported by the activities of VCU and the university's students.



Since VCU's activity represents an investment by various parties, including students, taxpayers, and society as a whole, we also evaluated VCU as an investment to see the value it provides to these investors. For each dollar invested by students, taxpayers, and society, VCU offers a benefit of **$6.30**, **$2.00**, and **$7.90**, respectively. These results indicate that VCU is an attractive investment to students with rates of return that exceed alternative investment opportunities. At the same time, the presence of VCU expands Virginia's economy and creates a wide range of positive social benefits that accrue to taxpayers and society in general within Virginia.

Modeling the impact of VCU is subject to many factors, the variability of which we considered in our sensitivity analysis (Appendix 2). With this variability accounted for, we present the findings of this study as a robust picture of the economic value of VCU.

Lightcast

Lightcast provides colleges and universities with labor market data that help create better outcomes for students, businesses, and communities. Our data, which cover more than 99% of the U.S. workforce, are compiled from a wide variety of government sources, job postings, and online profiles and résumés. Hundreds of institutions use Lightcast to align programs with regional needs, drive enrollment, connect students with in-demand careers, track their alumni's employment outcomes, and demonstrate their institution's economic impact on their region. Visit lightcast.io/solutions/education to learn more or connect with us.

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Appendix 1: Acknowledgments

Special thanks are due to the VCU staff listed in the table below who contributed to the data collection for this study. This study would not have been possible without the efforts of these individuals.

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Appendix 2: Sensitivity analysis

Sensitivity analysis measures the extent to which a model's outputs are affected by hypothetical changes in the background data and assumptions. This is especially important when those variables are inherently uncertain. This analysis allows us to identify a plausible range of potential results that would occur if the value of any of the variables is in fact different from what was expected. In this chapter we test the sensitivity of the model to the following input factors: 1) the alternative education variable, 2) the labor import effect variable, 3) the student employment variables, 4) the discount rate, and 5) the retained student variable.

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 university in the state. Given the difficulty in accurately specifying the alternative education variable, we test the sensitivity of the taxpayer and social 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 A2.1. Next, the model brackets the base case assumption on either side with a plus or minus 10%, 25%, and 50% variation in assumptions. Analyses are then repeated introducing one change at a time, holding all other variables constant. For example, an increase of 10% in the alternative education assumption (from 15% to 17%) reduces the taxpayer perspective rate of return from 11.5% to 10.8%. Likewise, a decrease of 10% (from 15% to 14%) in the assumption increases the rate of return from 11.5% to 12.1%.

Table A2.1: Sensitivity analysis of alternative education variable, taxpayer and social perspectives

% variation in assumption	-50%	-25%	-10%	Base case	10%	25%	50%
Alternative education variable	**8%**	**11%**	**14%**	**15%**	**17%**	**19%**	**23%**
Taxpayer perspective							
Net present value (millions)	$735.6	$680.8	$647.9	$626.0	$604.1	$571.2	$516.4
Rate of return	15.3%	13.2%	12.1%	11.5%	10.8%	10.0%	8.7%
Benefit-cost ratio	2.19	2.11	2.05	2.02	1.98	1.93	1.84
Social perspective							
Net present value (millions)	$12,472	$11,900	$11,557	$11,328	$11,100	$10,757	$10,185
Benefit-cost ratio	8.63	8.28	8.07	7.93	7.79	7.58	7.23

Based on this sensitivity analysis, the conclusion can be drawn that VCU investment analysis results from the taxpayer and social perspectives are not very sensitive to relatively large variations in the alternative education variable. As indicated, results are still above threshold levels (a net present value greater than zero and a benefit-cost ratio greater than 1.0), 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 social perspectives is not very sensitive.

Labor import effect variable

The labor import effect variable only affects the alumni impact calculation in Table 3.16. In the model we assume a labor import effect variable of 50%, which means that 50% of the state's labor demands would have been satisfied without the presence of the university. In other words, businesses that hired the university's students could have substituted some of these workers with equally-qualified people from outside the state had there been no the university students to hire. Therefore, we attribute only the remaining 50% of the initial labor income generated by increased alumni productivity to the university.

Table A2.2 presents the results of the sensitivity analysis for the labor import effect variable. As explained earlier, the assumption increases and decreases relative to the base case of 50% by the increments indicated in the table. Alumni productivity impacts attributable to the university, for example, range from a high of $6.2 billion at a -50% variation to a low of $2.1 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 decreases. Even under the most conservative assumptions, the alumni impact on the Virginia economy still remains sizable.

Table A2.2: Sensitivity analysis of labor import effect variable

% variation in assumption	-50%	-25%	-10%	Base case	10%	25%	50%
Labor import effect variable	25%	38%	45%	50%	55%	63%	75%
Alumni impact (millions)	$6,151	$5,126	$4,511	$4,101	$3,690	$3,075	$2,050

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 who are employed while attending the university and 2) the percentage of earnings that working students receive relative to the earnings they would have received had they not chosen to attend the university. Both employment variables affect the investment analysis results from the student perspective.

Students incur substantial expense by attending the university 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 65% of students are

employed.[51] 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 who are working while attending the university earn only 82%, on average, of the earnings that they statistically would have received if not attending the university. This suggests that many students hold part-time jobs that accommodate their attendance of the university, though it is at an additional cost in terms of receiving a wage that is less than what they otherwise might make. The 82% variable is an estimation based on the average hourly wages of the most common jobs held by students while attending college relative to the average hourly wages of all occupations in Virginia. The model captures this difference in wages and counts it as part of the opportunity cost of time. As above, the 82% estimate is tested in the sensitivity analysis by changing it to 100% and then to 0%.

The changes generate results summarized in Table A2.3, with *A* defined as the percent of students employed and *B* defined as the percent that students earn relative to their full earning potential. Base case results appear in the shaded row; here the assumptions remain unchanged, with *A* equal to 65% and *B* equal to 82%. Sensitivity analysis results are shown in non-shaded rows. Scenario 1 increases *A* to 100% while holding *B* constant, Scenario 2 increases *B* to 100% while holding *A* constant, Scenario 3 increases both *A* and *B* to 100%, and Scenario 4 decreases both *A* and *B* to 0%.

Table A2.3: Sensitivity analysis of student employment variables

Variations in assumptions	Net present value (millions)	Internal rate of return	Benefit-cost ratio
Base case: A = 65%, B = 82%	$3,013	22.0%	6.3
Scenario 1: A = 100%, B = 82%	$3,170	27.7%	8.6
Scenario 2: A = 65%, B = 100%	$3,077	23.9%	7.1
Scenario 3: A = 100%, B = 100%	$3,268	33.8%	11.3
Scenario 4: A = 0%, B = 0%	$2,722	16.4%	4.2

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

- **Scenario 1:** Increasing the percentage of students employed (*A*) from 65% to 100%, the net present value, internal rate of return, and benefit-cost ratio improve to $3.2 billion, 27.7%, and 8.6, 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 82% to 100%, the net present value, internal rate of return, and benefit-cost ratio results improve to $3.1 billion, 23.9%, and 7.1, respectively, relative to base case results; this strong improvement, again, is attributable to a lower opportunity cost of time.

51 Lightcast provided an estimate of the percentage of students employed from universities Lightcast has worked with in the past that collect this information. This figure excludes dual credit high school students, who are not included in the opportunity cost calculations. VCU's (National Survey of Student Engagement) NSSE survey results support the estimate of 65%. VCU's Spring 2023 NSSE survey found 19% of first year students worked at least one hour on campus and 35% off campus. 28% of VCU seniors reported working at least one hour on campus and 60% off campus.

- **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 $3.3 billion, 33.8%, and 11.3, 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 $2.7 billion, 16.4%, and 4.2, respectively, relative to base case results. These results are reflective of an increased opportunity cost; none of the students are employed in this case.[52]

It is strongly emphasized in this section that base case results are very attractive in that results are all above their threshold levels. As is clearly demonstrated here, results of the first three alternative scenarios appear much more attractive, although they overstate benefits. Results presented in Chapter 4 are realistic, indicating that investments in the university generate excellent returns, well above the long-term average percent rates of return in stock and bond markets.

Discount rate

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

Table A2.4: Sensitivity analysis of discount rate

% variation in assumption	-50%	-25%	-10%	Base case	10%	25%	50%
Student perspective							
Discount rate	2.4%	3.7%	4.4%	4.9%	5.4%	6.1%	7.3%
Net present value (millions)	$5,131	$3,908	$3,339	$3,013	$2,723	$2,347	$1,843
Benefit-cost ratio	10.0	7.8	6.8	6.3	5.8	5.1	4.2
Taxpayer perspective							
Discount rate	0.37%	0.55%	0.66%	0.73%	0.81%	0.92%	1.10%
Net present value (millions)	$688.3	$656.4	$638.0	$626.0	$614.3	$597.1	$569.6
Benefit-cost ratio	2.12	2.07	2.04	2.02	2.00	1.97	1.93
Social perspective							
Discount rate	0.37%	0.55%	0.66%	0.73%	0.81%	0.92%	1.10%
Net present value (millions)	$11,949	$11,631	$11,448	$11,328	$11,212	$11,041	$10,767
Benefit-cost ratio	8.3	8.1	8.0	7.9	7.9	7.8	7.6

52 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.

known returns of less risky assets where the investors might alternatively consider placing their money.

In this study, we assume a 4.9% discount rate for students and a 0.7% discount rate for society and taxpayers.[53] Similar to the sensitivity analysis of the alternative education variable, we vary the base case discount rates for students, taxpayers, and society 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 payback period is based on the undiscounted cash flow, it is unaffected by changes in the discount rate.

As demonstrated in Table A2.4, 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 4.9% to 7.3%) reduces the students' benefit-cost ratio from 6.3 to 4.2. Conversely, reducing the discount rate for students by 50% (from 4.9% to 2.4%) increases the benefit-cost ratio from 6.3 to 10.0. The sensitivity analysis results for taxpayers and society show the same inverse relationship between the discount rate and the benefit-cost ratio.

Retained student variable

The retained student variable only affects the student spending impact calculation in Table 3.13. For this analysis, we assume a retained student variable of 10%, which means that 10% of the university's students who originated from Virginia would have left the state for other opportunities, whether that be education or employment, if the university did not exist. The money these retained students spent in the state for accommodation and other personal and household expenses is attributable to the university.

Table A2.5 presents the results of the sensitivity analysis for the retained student variable. The assumption increases and decreases relative to the base case of 10% by the increments indicated in the table. The student spending impact is recalculated at each value of the assumption, holding all else constant. Student spending impacts attributable to the university range from a high of $174.2 million when the retained student variable is 15% to a low of $129.3 million when the retained student variable is 5%. This means as the retained student variable decreases, the student spending attributable to the university decreases. Even under the most conservative assumptions, the student spending impact on the Virginia economy remains substantial.

Table A2.5: Sensitivity analysis of retained student variable

% variation in assumption	-50%	-25%	-10%	Base case	10%	25%	50%
Retained student variable	5%	8%	9%	10%	11%	13%	15%
Student spending impact (thousands)	$129,253	$140,490	$147,232	$151,727	$156,222	$162,964	$174,201

53 These values are based on the three-year average of the baseline forecasts for the 10-year Treasury rate published by the Congressional Budget Office and the real Treasury interest rates reported by the Office of Management and Budget for 30-year investments. See the Congressional Budget Office "Table 5. Federal Student Loan Programs: Projected Interest Rates: CBO's July 2023 Baseline" and the Office of Management and Budget "Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses."

Appendix 3: Glossary of terms

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

Alternative use of funds: A measure of how monies that are currently used to fund VCU might otherwise have been used if VCU 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: The rate at which students leave the workforce due to out-migration, unemployment, retirement, or death.

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

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

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

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

Discounting: Expressing future revenues and costs in present value terms.

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

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

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 or decreases total enrollment by a significant amount, demand is elastic. If enrollment remains the same or changes only slightly, demand is inelastic.

Externalities: Impacts (positive and negative) for which there is no compensation. Positive externalities of education include improved social behaviors such as improved health, lower crime, and reduced demand for income assistance. Educational institutions do not receive compensation for these benefits, but benefits still occur because education is statistically proven to lead to improved social behaviors.

Gross 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 added income.

Initial effect: Income generated by the initial injection of monies into the economy through the payroll of VCU and the higher earnings of the university's students.

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

Multiplier effect: Additional income created in the economy as VCU and the university's 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 VCU and the university's students (i.e., the direct effect), income created by the supply chain of the initial supply chain (i.e., the indirect effect), and the income created by the increased spending of the household sector (i.e., the induced effect).

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

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

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

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

Opportunity cost: Benefits 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 4: Frequently asked questions (FAQs)

This appendix provides answers to some frequently asked questions about the results.

What is economic impact analysis?

Economic impact analysis quantifies the impact from a given economic event—in this case, the presence of an institution—on the economy of a specified region.

What is investment analysis?

Investment analysis is a standard method for determining whether an existing or proposed investment is economically viable. This methodology is appropriate in situations where a stakeholder puts up a certain amount of money with the expectation of receiving benefits in return, where the benefits that the stakeholder receives are distributed over time, and where a discount rate must be applied in order to account for the time value of money.

Do the results differ by region, and if so, why?

Yes. Regional economic data are drawn from Lightcast's proprietary MR-SAM model, the Census Bureau, and other sources to reflect the specific earnings levels, jobs numbers, unemployment rates, population demographics, and other key characteristics of the region served by the institution. Therefore, model results for the institution are specific to the given region.

Are the funds transferred to the institution increasing in value, or simply being re-directed?

Lightcast's approach is not a simple "rearranging of the furniture" where the impact of operations spending is essentially a restatement of the level of funding received by the institution. Rather, it is an impact assessment of the additional income created in the state as a result of the institution's spending on payroll and other non-pay expenditures, net of any impacts that would have occurred anyway if the institution did not exist.

How do my institution's rates of return compare to that of other institutions?

In general, Lightcast discourages comparisons between institutions since many factors, such as regional economic conditions, institutional differences, and student demographics are outside of the institution's control. It is best to compare the rate of return to the discount rates of 4.9% (for students) and 0.7% (for society and taxpayers), which can also be seen as the opportunity cost of the investment (since these stakeholder groups could be spending their time and money in other investment schemes besides education). If the rate of return is higher than the discount rate, the stakeholder groups can expect to receive a positive return on their educational investment.

Lightcast recognizes that some institutions may want to make comparisons. As a word of caution, if comparing to an institution that had a study commissioned by a firm other than Lightcast, then differences in methodology will create an "apples to oranges" comparison and will therefore be difficult. The study results should be seen as unique to each institution.

Net present value (NPV): How do I communicate this in laymen's terms?

Which would you rather have: a dollar right now or a dollar 30 years from now? That most people will choose a dollar now is the crux of net present value. The preference for a dollar today means today's dollar is therefore worth more than it would be in the future (in most people's opinion). Because the dollar today is worth more than a dollar in 30 years, the dollar 30 years from now needs to be adjusted to express its worth today. Adjusting the values for this "time value of money" is called discounting and the result of adding them all up after discounting each value is called net present value.

Internal rate of return (IRR): How do I communicate this in laymen's terms?

Using the bank as an example, an individual needs to decide between spending all of their paycheck today and putting it into savings. If they spend it today, they know what it is worth: $1 = $1. If they put it into savings, they need to know that there will be some sort of return to them for spending those dollars in the future rather than now. This is why banks offer interest rates and deposit interest earnings. This makes it so an individual can expect, for example, a 3% return in the future for money that they put into savings now.

Total economic impact: How do I communicate this in laymen's terms?

Big numbers are great but putting them into perspective can be a challenge. To add perspective, find an industry with roughly the same "% of GSP" as your institution (Table 2.3). This percentage represents its portion of the total gross state product in the state (similar to the nationally recognized gross domestic product but at a state level). This allows the institution to say that their single brick and mortar campus does just as much for the state as the entire Utilities *industry*, for example. This powerful statement can help put the large total impact number into perspective.

Appendix 5: Example of sales versus income

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

Income = Sales – Intermediary Costs

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

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

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

Income = $5.00 – $3.00 = $2.00

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

Appendix 6: Lightcast MR-SAM

Lightcast's MR-SAM represents the flow of all economic transactions in a given region. It replaces Lightcast's previous input-output (IO) model, which operated with some 1,000 industries, four layers of government, a single household consumption sector, and an investment sector. The old IO model was used to simulate the ripple effects (i.e., multipliers) in the regional economy as a result of industries entering or exiting the region. The MR-SAM model performs the same tasks as the old IO model, but it also does much more. Along with the same 1,000 industries, government, household, and investment sectors embedded in the old IO tool, the MR-SAM exhibits much more functionality, a greater amount of data, and a higher level of detail on the demographic and occupational components of jobs (16 demographic cohorts and about 750 occupations are characterized).

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

Data sources for the model

The Lightcast 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.

Lightcast 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 Lightcast MR-SAM model to produce an industry-by-industry matrix describing all industry purchases from all industries.

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

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

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

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

Census of Government's (CoG) the government of Virginia and local government finance dataset is used specifically to aid breaking out state and local data that is reported in the MUTs. This allows Lightcast to have unique production functions for each of its the government of Virginia 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 Lightcast 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 Lightcast's gravitational flows model that estimates the amount of trade between counties in the country.

Overview of the MR-SAM model

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

National SAM

Following standard practice, the SAM model appears as a square matrix, with each row sum exactly equaling the corresponding column sum. Reflecting its kinship with the standard Leontief input-output framework, individual SAM elements show 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 1,000 detailed accounts.

Multi-regional aspect of the MR-SAM

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

Lightcast'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 Lightcast'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 considers the distance, type of roads, rail lines, and other modes of transportation. Once this is calculated for every county-to-county pair, a set of mathematical operations is performed to make sure all counties absorb the correct amount of supply from every county and the correct amount of demand from every county. These operations produce more than 200 million data points.

Components of the Lightcast MR-SAM model

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

County earnings distribution matrix

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

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

Commuting model

The commuting sub-model is an integral part of Lightcast's MR-SAM model. It allows the regional and multi-regional models to know what amount of the earnings can be

attributed to place-of-residence vs. place-of-work. The commuting data describe the flow of earnings from any county to any other county (including within the counties themselves). For this situation, the commuted earnings are not just a single value describing total earnings flows over a complete year but are broken out by occupation and demographic. Breaking out the earnings allows for analysis of place-of-residence and place-of-work earnings. These data are created using Bureau of Labor Statistics' OnTheMap dataset, Census' Journey-to-Work, BEA's LPI CA91 and CA05 tables, and some of Lightcast's data. The process incorporates the cleanup and disaggregation of the OnTheMap data, the estimation of a closed system of county inflows and outflows of earnings, and the creation of finalized commuting data.

National SAM

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

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

Gravitational flows model

The most important piece of the Lightcast 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 7: Value per credit hour equivalent and the Mincer function

Two key components in the analysis are 1) the value of the students' educational achievements, and 2) the change in that value over the students' working careers. Both of these components are described in detail in this appendix.

Value per CHE

Typically, the educational achievements of students are marked by the credentials they earn. However, not all students who attended the university in FY 2023-24 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 university, not just those who earned a credential.

To calculate the value per CHE, we first determine how many CHEs are required to complete each education level. For example, assuming that there are 30 CHEs in an academic year, a student generally completes 120 CHEs in order to move from a high school diploma to a bachelor's degree, another 60 CHEs to move from a bachelor's degree to a master's degree, and so on. This progression of CHEs generates an education ladder beginning at the less than high school level and ending with the completion of a doctoral degree, with each level of education representing a separate stage in the progression.

The second step is to assign a unique value to the CHEs in the education ladder based on the wage differentials presented in Table 2.4. For example, the difference in state earnings between a high school diploma and a bachelor's degree is $34,600. We spread this $34,600 wage differential across the 120 CHEs that occur between a high school diploma and a bachelor's degree, applying a ceremonial "boost" to the last CHE in the stage to mark the achievement of the degree.[54] We repeat this process for each education level in the ladder.

Next, we map the CHE production of the FY 2023-24 student population to the education ladder. Table 2.2 provides information on the CHE production of students attending the university, broken out by educational achievement. In total, students completed

54 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 Lightcast impact model are derived from Jaeger and Page (1996).

717,284 CHEs during the analysis year. We map each of these CHEs to the education ladder depending on the students' education level and the average number of CHEs they completed during the year. For example, bachelor's degree graduates are allocated to the stage between the associate degree and the bachelor's degree, and the average number of CHEs they completed informs the shape of the distribution curve used to spread out their total CHE production within that stage of the progression.

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

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

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

Table A7.1 displays the result for the students' aggregate annual increase in income (*ΔE)*, a total of $254.5 million. By dividing this value by the students' total production of 717,284 CHEs during the analysis year, we derive an overall value of $355 per CHE.

Table A7.1: Aggregate annual increase in income of students and value per CHE

Aggregate annual increase in income	$254,485,558
Total credit hour equivalents (CHEs) in FY 2023-24	717,284
Value per CHE	**$355**

Source: Lightcast impact model

Mincer function

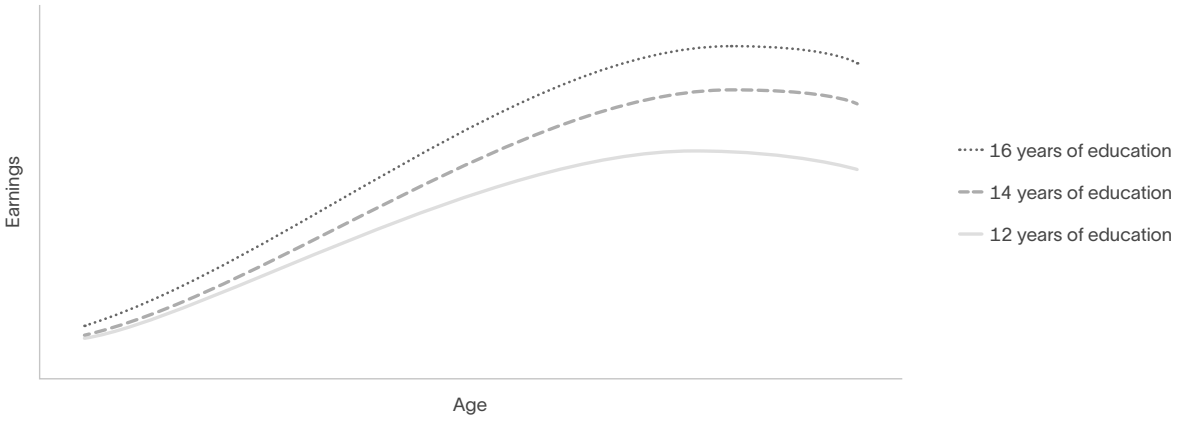
The $355 value per CHE in Table A7.1 only tells part of the story, however. Human capital theory holds that earnings levels do not remain constant; rather, they start relatively low and gradually increase as the worker gains more experience. Research also shows that the earnings increment between educated 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.[55] 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%.

55 See Mincer (1958 and 1974).

We use IPUMS (originally the "Integrated Public Use Microdata Series") data to calculate Mincer coefficients. The database contains over 60 integrated, high precision samples of the American population drawn from 16 federal census, from the American Community Surveys of 2000 – present, and from the Puerto Rican Community Surveys of 2005 – present. By using this data, we are able to create demographic and education level-specific Mincer coefficients. These coefficients are used in a quartic equation, which explains earnings with the years of education and work experience variables accounting for demographic characteristics through interaction terms with sex and race and ethnicity.

Figure A7.1 illustrates several important points about the Mincer function. First, as demonstrated by the shape of the curves, an individual's earnings initially grow at an increasing rate, then grow at a decreasing rate, reach a maximum somewhere well after the midpoint of the working career, and then decline in later years. Second, individuals with higher levels of education reach their maximum earnings at an older age compared to individuals with lower levels of education (recall that age serves as a proxy for years of experience). And third, the benefits of education, as measured by the difference in earnings between education levels, increase with age.

Figure A7.1: Lifecycle change in earnings



In calculating the alumni impact in Chapter 3, we use the slope of the curve in Mincer's earnings function to condition the $355 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 $355 value per CHE applies only to the CHE production of students precisely at the midpoint of their careers during the analysis year.

In Chapter 4 we again apply the Mincer function, this time to project the benefits stream of the FY 2023-24 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 A7.1.

Appendix 8: Alternative education variable

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

Recall this analysis considers only relevant economic information regarding the university. Considering the existence of various other academic institutions surrounding the university, we have to assume that a portion of the students could find alternative education and either remain in or return to the state. 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 the state upon completing their studies. For these students—who would have found an alternative education and produced benefits in the state regardless of the presence of the university—we discount the benefits attributed to the university. An important distinction must be made here: the benefits from students who would find alternative education outside the state and not return to the state are *not* discounted. Because these benefits would not occur in the state without the presence of the university, they must be included.

In the absence of the university, we assume 15% of the university's students would find alternative education opportunities and remain in or return to the state. We account for this by discounting the alumni impact, the benefits to taxpayers, and the benefits to society in the state in Chapters 3 and 4 by 15%. In other words, we assume 15% of the benefits created by the university's students would have occurred anyway in the counterfactual scenario where the university did not exist. A sensitivity analysis of this adjustment is presented in Appendix 2.

Appendix 9: Overview of investment analysis measures

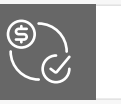
The appendix provides context to the investment analysis results using the simple hypothetical example summarized in Table A9.1 below. The table shows the projected benefits and costs for a single student over time and associated investment analysis results.[56]

Table A9.1: Example of the benefits and costs of education for a single student

1	2	3	4	5	6
Year	**Tuition**	**Opportunity cost**	**Total cost**	**Higher earnings**	**Net cash flow**
1	$1,500	$20,000	$21,500	$0	-$21,500
2	$0	$0	$0	$5,000	$5,000
3	$0	$0	$0	$5,000	$5,000
4	$0	$0	$0	$5,000	$5,000
5	$0	$0	$0	$5,000	$5,000
6	$0	$0	$0	$5,000	$5,000
7	$0	$0	$0	$5,000	$5,000
8	$0	$0	$0	$5,000	$5,000
9	$0	$0	$0	$5,000	$5,000
10	$0	$0	$0	$5,000	$5,000
Net present value			**$21,500**	**$35,753**	**$14,253**

Benefit-cost ratio
1.7

Internal rate of return
18.0%



Payback period (years)
4.2

Assumptions are as follows:

- Benefits and costs are projected out 10 years into the future (Column 1).
- The student attends the university for one year, and the cost of tuition is $1,500 (Column 2).
- Earnings forgone while attending the university for one year (opportunity cost) come to $20,000 (Column 3).

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

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

Results are expressed in standard investment analysis terms, which are as follows: the net present value, the internal rate of return, the benefit-cost ratio, and the payback period. Each of these is briefly explained below in the context of the cash flow numbers presented in Table A9.1.

Net present value

The student in Table A9.1 can choose either to attend college or to forgo post-secondary education and maintain his present employment. If he decides to enroll, certain economic implications unfold. Tuition and fees must be paid, and earnings will cease for one year. In exchange, the student calculates that with post-secondary education, his earnings will increase by at least the $5,000 per year, as indicated in the table.

The question is simple: Will the prospective student be economically better off by choosing to enroll? If he adds up higher earnings of $5,000 per year for the remaining nine years in Table A9.1, 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.[57]

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

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

The goal is to express all future higher earnings in present value terms so that they can be compared to investments incurred today (in this example, tuition plus earnings forgone). As indicated in Table A9.1 the cumulative present value of $5,000 worth of higher earnings between years 2 and 10 is $35,753 given the 4% interest rate, far lower than the undiscounted $45,000 discussed above.

The net present value of the investment is $14,253. This is simply the present value of the benefits less the present value of the costs, or $35,753 - $21,500 = $14,253. In other words, the present value of benefits exceeds the present value of costs by as much as $14,253. The criterion for an economically worthwhile investment is that the net present value is equal to or greater than zero. Given this result, it can be concluded that, in this case, and given these assumptions, this particular investment in education is very strong.

Internal rate of return

The internal rate of return is another way of measuring the worth of investing in education using the same cash flows shown in Table A9.1. 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 A9.1. Or, if a discount rate of 18.0% were applied to the net present value calculations instead of the 4%, then the net present value would reduce to zero.

What does this mean? The internal rate of return of 18.0% defines a breakeven solution—the point where the present value of benefits just equals the present value of costs, or where the net present value equals zero. Or, at 18.0%, higher earnings of $5,000 per year for the next nine years will earn back all investments of $21,500 made plus pay 18.0% for the use of that money ($21,500) in the meantime. Is this a good return? Indeed, it is. If it is compared to the 4% going rate of interest applied to the net present value calculations, 18.0% is far higher than 4%. It may be concluded, therefore, that the investment in this case is solid. Alternatively, comparing the 18.0% rate of return to the long-term 10.1% rate or so obtained from investments in stocks and bonds also indicates that the investment in education is strong relative to the stock market returns (on average).

Benefit-cost ratio

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

would not be feasible. The 1.7 ratio means that a dollar invested today will return a cumulative $1.70 over the ten-year time period.

Payback period

This is the length of time from the beginning of the investment (consisting of tuition and earnings forgone) until higher future earnings give a return on the investment made. For the student in Table A9.1, 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 university. 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 10: Shutdown point

The investment analysis in Chapter 4 weighs the benefits generated by the university against taxpayer funding in Virginia and local taxpayer funding that the university receives to support its operations. An important part of this analysis is factoring out the benefits that the university would have been able to generate anyway, even without state and local taxpayer support. This adjustment is used to establish a direct link between what taxpayers pay and what they receive in return. If the university is able to generate benefits without taxpayer support, then it would not be a true investment.[58]

The overall approach includes a sub-model that simulates the effect on student enrollment if the university loses its state and local funding and has to raise student tuition and fees in order to stay open. If the university can still operate without state and local support, then any benefits it generates at that level are discounted from total benefit estimates. If the simulation indicates that the university cannot stay open; however, then benefits are directly linked to costs, and no discounting applies. This appendix documents the underlying theory behind these adjustments.

The government of Virginia and local government support versus student demand for education

Figure A10.1 presents a simple model of student demand and the government of Virginia and local government support. The right side of the graph is a standard demand curve (*D*) showing student enrollment as a function of student tuition and fees. Enrollment is measured in terms of total credit hour equivalents (CHEs) and expressed as a percentage of the university's current CHE production. Current student tuition and fees are represented by *p*', and the government of Virginia and local government support covers *C%* of all costs. At this point in the analysis, it is assumed that the university has only two sources of revenues: 1) student tuition and fees and 2) the government of Virginia and local government support.

Figure A10.2 shows another important reference point in the model—where the government of Virginia and local government support is 0%, student tuition and fees are increased to *p*", and CHE production is at *Z%* (less than 100%). The reduction in CHEs reflects the price elasticity of the students' demand for education, i.e., the extent to which the students' decision to attend the university is affected by the change in tuition and fees. Ignoring for the moment those issues concerning the university's minimum operating scale (considered below in the section called "Calculating benefits at the

58 Of course, as a public training provider, the university would not be permitted to continue without public funding, so the situation in which it would lose all state support is entirely hypothetical. The purpose of the adjustment factor is to examine the university in standard investment analysis terms by netting out any benefits it may be able to generate that are not directly linked to the costs of supporting it.

shutdown point"), the implication for the investment analysis is that benefits to the government of Virginia and local government must be adjusted to net out the benefits that the university can provide absent the government of Virginia and local government support, represented as *Z%* of the university's current CHE production in Figure A10.2.

Figure A10.1: Student demand and government funding by tuition and fees

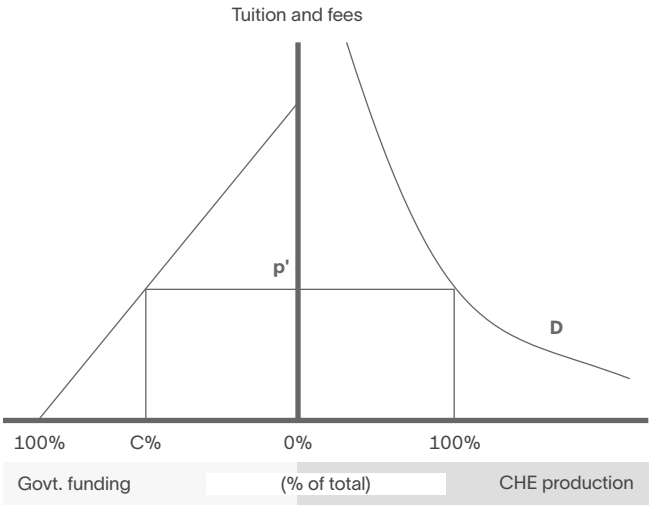
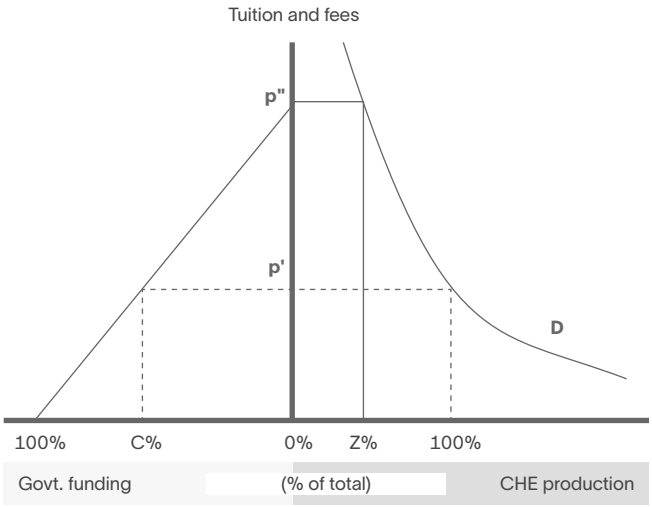


Figure A10.2: CHE production and government funding by tuition and fees



To clarify the argument, it is useful to consider the role of enrollment in the larger benefit-cost model. Let *B* equal the benefits attributable to the government of Virginia and local government support. The analysis derives all benefits as a function of student enrollment, measured in terms of CHEs produced. For consistency with the graphs in this appendix, *B* is expressed as a function of the percent of the university's current CHE production. Equation 1 is thus as follows:

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

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

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

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

Inasmuch as the benefits in equation 2 occur with or without the government of Virginia and local government support, the benefits appropriately attributed to the government of Virginia and local government support are given by equation 3 as follows:

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

Calculating benefits at the shutdown point

Colleges and universities cease to operate when the revenue they receive from the quantity of education demanded is insufficient to justify their continued operations. This is commonly known in economics as the shutdown point.[59] The shutdown point is introduced graphically in Figure A10.3 as *S%*. The location of point *S%* indicates that the university can operate at an even lower enrollment level than *Z%* (the point at which the university receives zero the government of Virginia and local government funding). The government of Virginia and local government support at point *S%* is still zero, and student tuition and fees have been raised to *p'''*. The government of Virginia and local government support is thus credited with the benefits given by equation 3, or *B = B (100%) – B (Z%)*. With student tuition and fees still higher than *p'''*, the university would no longer be able to attract enough students to keep the doors open, and it would shut down.

Figure A10.4 illustrates yet another scenario. Here, the shutdown point occurs at a level of CHE production greater than *Z%* (the level of zero the government of Virginia and local government support), meaning some minimum level of the government of Virginia and local government support is needed for the university to operate at all. This minimum portion of overall funding is indicated by *S'%* on the left side of the chart, and as before, the shutdown point is indicated by *S%* on the right side of chart. In this case, the government of Virginia and local government support is appropriately credited with all the benefits generated by the university's CHE production, or *B = B (100%)*.

Figure A10.3: Shutdown point after zero government funding

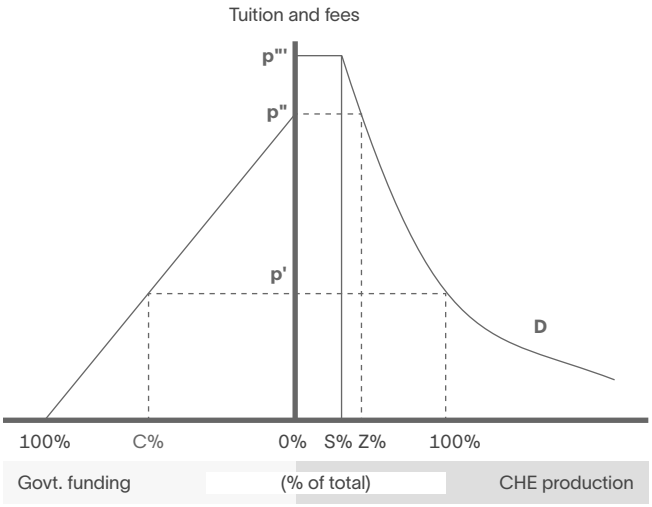
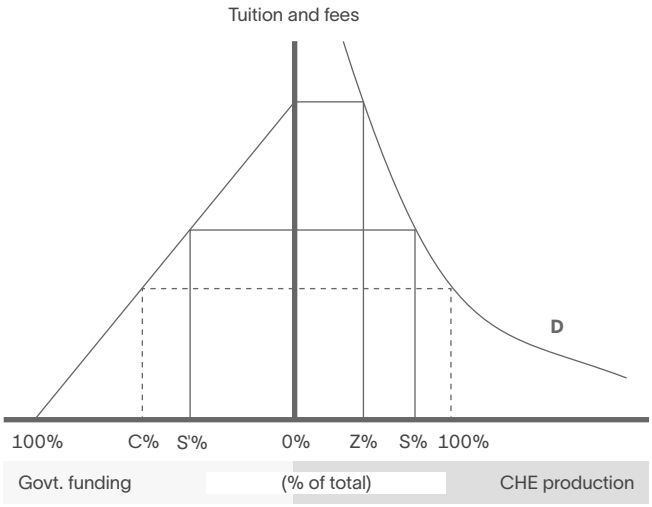


Figure A10.4: Shutdown point before zero government funding



59 In the traditional sense, the shutdown point applies to firms seeking to maximize profits and minimize losses. Although profit maximization is not the primary aim of colleges and universities, the principle remains the same, i.e., that there is a minimum scale of operation required in order for colleges and universities to stay open.

Appendix 11: Social externalities

Education has a predictable and positive effect on a diverse array of social benefits. These, when quantified in dollar terms, represent significant social savings that directly benefit society communities and citizens throughout the state, including taxpayers. In this appendix we discuss the following three main benefit categories: 1) improved health, 2) reductions in crime, and 3) reduced demand for government-funded income assistance.

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

Health

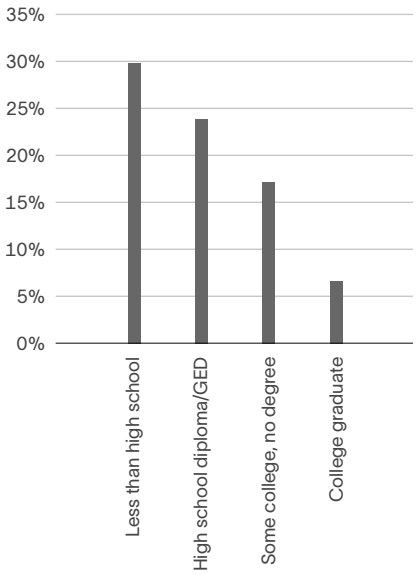
Statistics show a correlation between increased education and improved health. The manifestations of this are found in five health-related variables: smoking, obesity, depression, and substance abuse. There are other health-related areas that link to educational attainment, but these are omitted from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

Smoking

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

Figure A11.1 shows the prevalence of cigarette smoking among adults, 21 years and over, based on data provided by the National Survey on Drug use and Health.[60] The data include adults who reported smoking in the last month. As indicated, prevalence of cigarette smoking declines after high school diploma or high school equivalency level of education.

Figure A11.1: Prevalence of smoking among U.S. adults by education level



Source: National Survey on Drug Use and Health

60 National Survey on Drug Use and Health. "Table 2.18B—Cigarette Use in Past Month: Among People Aged 12 or Older; by Age Group and Demographic Characteristics, Percentages, 2021 and 2022."

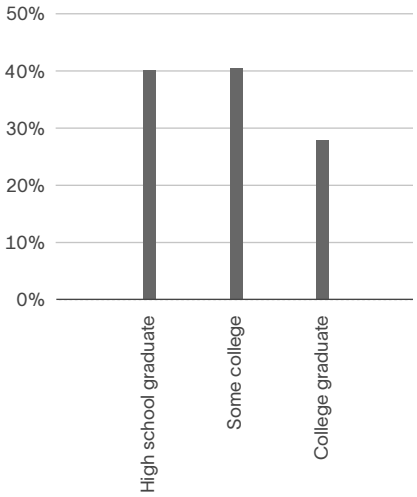
The National Survey on Drug Use and Health also reports the percentage of adults who are current smokers by state.[61] We use this information to create an index value by which we adjust the national prevalence data on smoking to each state. For example, 14.9% of Virginia adults were smokers in 2022, relative to 16.7% for the nation. We thus apply a scalar 0.89 to the national probabilities of smoking in order to adjust them to the state of Virginia.

Obesity

The rise in obesity and diet-related chronic diseases has led to increased attention on how expenditures relating to obesity have increased in recent years. The average cost of obesity-related medical conditions is calculated using information from the *Journal of Occupational and Environmental Medicine*, which reports incremental medical expenditures and productivity losses due to excess weight.[62]

Data for Figure A11.2 is derived from the National Center for Health Statistics which shows the prevalence of obesity among adults aged 20 years and over by education, gender, and ethnicity.[63] As indicated, college graduates are less likely to be obese than individuals with a high school diploma. However, the prevalence of obesity among adults with some college is actually greater than those with just a high school diploma. In general, though, obesity tends to decline with increasing levels of education.

Figure A11.2: Prevalence of obesity by education level



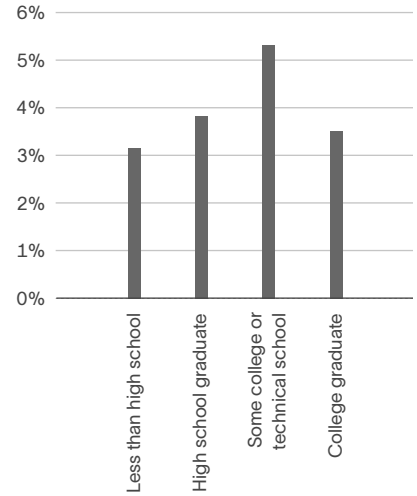
Source: Derived from data provided by the National Center for Health Statistics

Depression

Capturing the full economic cost of mental illness is difficult because not all mental disorders have a correlation with education. For this reason, we only examine the economic costs associated with major depressive disorder (MDD), which comprise medical and pharmaceutical costs, workplace costs such as absenteeism, and suicide-related costs.[64]

Figure A11.3 summarizes the prevalence of major depressive episodes (MDE) with severe impairment and treatment for depression among adults by education level, based on data provided by the National Survey on Drug Use and Health.[65] As shown, people with some college education are most likely to have an MDE with severe impairment and seek treatment for depression compared to those with other levels of educational attainment. People with a high school diploma or less, along with college graduates, are all fairly similar in the prevalence rates.

Figure A11.3: Prevalence of major depressive episode with severe impairment and treatment for depression by education level



Source: National Survey on Drug Use and Health

61 National Survey on Drug Use and Health. "Table 20. Cigarette Use in the Past Month: Among People Aged 12 or Older, by Age Group and State, Annual Average Percentages, 2021 and 2022."

62 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.

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

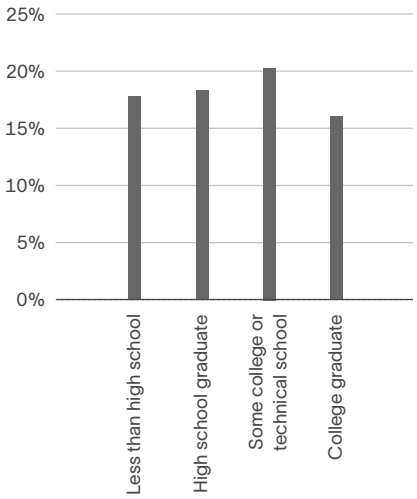
64 Greenberg, Paul, Andree-Anne Fournier, Tammy Sisitsky, Crystal Pike, and Ronald Kesslaer. "The Economic Burden of Adults with Major Depressive Disorder in the United States (2019)." *Adv Ther* 40, 4460-4479 (2023).

65 National Survey on Drug Use and Health. "Table 6.43A—Receipt of Treatment for Depression in Past Year: Among People Aged 18 or Older with Major Depressive Episode (MDE) and among People Aged 18 or Older with MDE with Severe Impairment in Past Year; by Geographic, Socioeconomic, and Health Characteristics, Numbers in Thousands, 2021 and 2022."

Substance abuse

The burden and cost of substance abuse is enormous in the U.S., but little is known about the magnitude of costs and effects at a national level. What is known is that the rate of people abusing substances 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 or alcohol is 17.8%, slightly larger than the probability of substance abuse for college graduates (16.1%). This relationship is presented in Figure A11.4 based on data supplied by the National Survey on Drug Use and Health.[66] Prevalence does not strictly decline at every education level. Health Costs associated with substance abuse include health, productivity, traffic collisions, fire, and research and prevention.[67]

Figure A11.4: Prevalence of substance dependence or abuse by education level



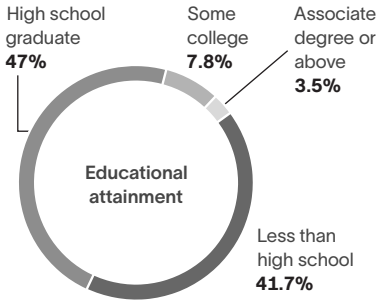
Source: Substance Abuse and Mental Health Services Administration

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 A11.5 displays the educational attainment of the incarcerated population in the U.S. Data are derived from the breakdown of the inmate population by education level in federal, state, and local prisons as provided by the U.S. Bureau of Justice Statistics.[68]

Figure A11.5: Educational attainment of the incarcerated population



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

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.[69]

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

66 National Survey on Drug Use and Health. "Table 5.10B—Substance Use Disorder in Past Year: Among People Aged 12 or Older; by Age Group and Demographic Characteristics, Percentages, 2021 and 2022."

67 Marwood Group. "Economic Cost of Substance Abuse Disorder in the United States, 2019." *Recovery Centers of America*.

68 Nowotny, Kathryn, Ryan Masters, and Jason Boardman, 2016. "The relationship between education and health among incarcerated man and women in the United States" *BMC Public Health*. September 2016.

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

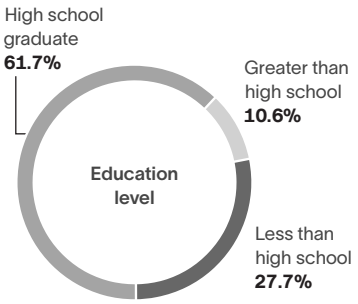
Income assistance

Statistics show that as education levels increase, the number of applicants for government-funded income assistance such as welfare and unemployment benefits declines. Welfare and unemployment claimants can receive assistance from a variety of different sources, including Temporary Assistance for Needy Families (TANF), Supplemental Nutrition Assistance Program (SNAP), Medicaid, Supplemental Security Income (SSI), and unemployment insurance.[70]

Figure A11.6 relates the breakdown of TANF recipients by education level, derived from data provided by the U.S. Department of Health and Human Services.[71] As shown, the demographic characteristics of TANF recipients are weighted heavily toward the less than high school and high school categories, with a much smaller representation of individuals with greater than a high school education.

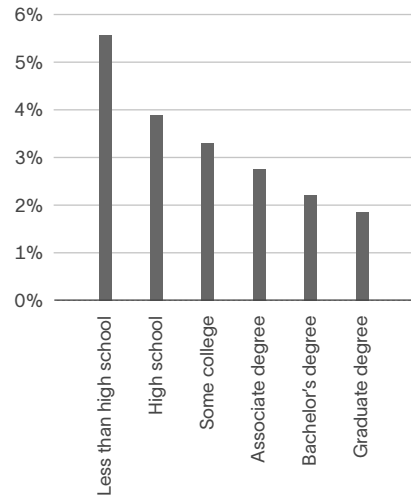
Unemployment rates also decline with increasing levels of education, as illustrated in Figure A11.7. These data are provided by the Bureau of Labor Statistics.[72] As shown, unemployment rates range from 5.6% for those with less than a high school diploma to 1.8% for those at the graduate degree level or higher.

Figure A11.6: Breakdown of TANF recipients by education level



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

Figure A11.7: Unemployment by education level



Source: Bureau of Labor Statistics

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

71 U.S. Department of Health and Human Services, Office of Family Assistance. "Characteristics and Financial Circumstances of TANF Recipients, Fiscal Year 2022."

72 Bureau of Labor Statistics. "Table 7. Employment status of the civilian noninstitutional population 25 years and over by educational attainment, sex, race, and Hispanic or Latino ethnicity." Current Population Survey, Labor Force Statistics, Household Data Annual Averages, 2023.