The Impact of the University of Illinois on the Economy of Our State

Robert Resek
Geoffrey J.D. Hewings
Darren Lubotsky
Finley Edwards

Prepared by the Institute of Government and Public Affairs
Robert F. Rich, Director

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INSTITUTE OF GOVERNMENT & PUBLIC AFFAIRS
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Executive Summary

The University of Illinois serves nearly 70,000 students at three campuses and two satellite medical campuses, employs more than 30,000 faculty, staff and graduate assistants and operates with an annual budget of more than $4 billion. The State of Illinois' investment in the University is substantial. This report examines the benefits of the University to the state.

The authors of this report have examined separate aspects of the University's contributions to the state's economy: the impact of the University's spending for wages, salaries, materials and services and the contribution of the University's alumni; the benefits to the economy that result from the greater earning power that higher education brings; and the benefits to the economy of increased worker productivity that a higher education provides.

We have found that:

- the University of Illinois produces about $13.1 billion per year in direct and indirect economic impact on the Illinois economy each year, including the creation of more than 150,000 jobs;
- the University's alumni, through their own wages and salaries, contribute about $21.2 billion per year to the state's economy, including more than 265,000 jobs;
- the University contributes $13.1 billion in expected increased lifetime earnings for its students each year;
- annual activity of the University creates $1.3 billion in future tax revenue to the state at a cost of $726 million, resulting in a net annual gain of about $535 million each year;
- each percentage point of population with college degrees adds $911 to average annual per capita income;
- there is a long list of non-monetary benefits received each year by University students and the state at large, including $350 million more in charitable contributions;
- and college graduates earn an average 57 percent more than high school graduates.

Introduction

The University of Illinois has campuses in Urbana-Champaign, Chicago and Springfield, medical campuses in Peoria and Rockford, and a presence in every county in the state through University of Illinois Extension. Nearly 70,000 students attend the University, which awards more than 18,000 degrees each year. A staff of more than 23,000 full-time equivalent employees and almost 10,000 graduate assistants support the University's education and research efforts.

The University of Illinois provides value to the state in a number of ways: educating the next work force, conducting research that adds to the value of goods and services produced by Illinoisans, providing an educational foundation that attracts and retains business, and offering cultural opportunities that strengthen communities across the state. However, quantifying the University's full impact on the state's economy is a complex task.

Our purpose in this report, which compiles separate research by the authors, is to explore the benefits to the state's economy of a University of Illinois education. We look at several factors that contribute to the University's impact:

- The wages and salaries paid to University employees, materials and services purchased by the University, and capital spending by the University flow into the economy in different ways. The wages earned by University alumni also bear on the state's fortunes.
- Students gain earning power through their education at the University that eventually flows back into the economy of the state and the nation.
- Higher education provides a variety of benefits to students and society that are not purely economic. We look at the impact of those nonmonetary benefits.
- The state also benefits from increases in state and local tax revenue because of the increased income a University of Illinois education delivers.
- Higher education also yields an increase in productivity, which leads to increases in state and national income.

The University contributes more than $13 billion in direct and indirect economic output in the state and is responsible for more than 150,000 jobs and more than $4 billion in annual income. The impact of an education at the University provides its students with more than $13 billion in expected increased lifetime earnings.

So while the state's investment in the University of Illinois, and in higher education overall, is substantial, the research here indicates the return from the University to the economy of the state makes that investment well worthwhile.

~Robert F. Rich

The Impact of University Spending[1]

The impact of the University of Illinois on the state's economy can be measured using the wages and salaries of University's approximately 30,000 employees and the purchases of materials and services by the University. These dollars spawn additional jobs and spending throughout the campus communities and the state at large.

The University of Illinois spends approximately $2.01 million per year for wages and salaries, excluding pension obligations, and about $1.6 million per year for materials and services. Adding these amounts together and allocating them throughout economic sectors allows us to calculate a combined economic impact as a result of the University's spending for these items, as shown in Table 1.

TABLE 1: Impact of University spending for wages, salaries, materials and services[2]

	Output (million $)	Employment (thousand)	Income (million $)
Resources	78.61	2.14	28.94
Construction	220.22	2.84	89.53
Nondurables	1,600.10	5.75	242.10
Durables	1,250.71	5.68	246.56
Transportation, Communications, Utilities	801.70	5.23	209.00
Trade	1,223.72	19.00	429.21
Finance, Insurance, Real Estate	2,025.24	16.36	481.93
Services	3,624.42	71.74	1,758.53
Government	92.78	1.58	55.05
Total	**10,917.49**	**130.32**	**3,540.85**

	Output (million $)	Employment (thousand)	Income (million $)
Direct	3,653.00	52.88	1,287.25
Indirect	7,264.49	77.44	2,253.60
(Multiplier)	2.99	2.46	2.75

So the direct impact of University spending on wages, salaries, materials and services is $3.653 billion ($2,078.3 million + $1,574.7 million). That money ripples through the economy creating an additional $1.99 of impact for every $1 spent, or about $7.3 billion of indirect impact, bringing **the total impact on the economy to $10.9 billion**.

[1] To check the gross effects on the Illinois economy, whole expenditure amount was treated as a shock in year 2009.

[2] Wage and salaries ($2,078.3 million) are reallocated to each sector using household's consumption shares. Material and services ($1,574.7 million) are assumed to be purchased proportionally to the input ratio of education service sector (SIC 82). Construction sector not included.

University spending also accounts for more than 130,000 jobs and more than $3.5 billion in annual income across the state's economy.

Additionally, the University spends about $662 million for capital improvements per year. These capital improvements include new buildings, construction and maintenance projects. This amount also can be allocated through the sectors of the economy and ripples through, creating an additional $2.26 for every dollar spent. The results can be seen in Table 2.

TABLE 2: Impact of University's capital spending[3]

	Output (million $)	Employment (thousand)	Income (million $)
Resources	14.77	0.43	6.21
Construction	696.90	9.00	283.34
Nondurables	250.67	0.85	36.72
Durables	340.71	1.67	69.34
Transportation, Communications, Utilities	102.05	0.65	26.49
Trade	151.22	2.00	50.24
Finance, Insurance, Real Estate	178.73	1.46	47.36
Services	408.82	7.90	197.51
Government	15.76	0.26	9.09
Total	**2,159.62**	**24.23**	**726.30**

	Output (million $)	Employment (thousand)	Income (million $)
Direct	662.00	8.55	269.15
Indirect	1,497.62	15.68	457.15
(Multiplier)	3.26	2.83	2.70

Capital spending adds about 24,000 jobs and $726 million in income to the economy, and produces an impact on Illinois's economic output of about $2.2 billion. Adding this $2.2 billion to the $10.9 billion economic output from salaries, materials and services delivers a **total impact of $13.1 billion.**

We should also calculate the economic contributions of the nearly 120,000 alumni of the University who continue to live in Illinois. Using an average salary of $55,794.84 for each person, we arrive at a total of almost $6.7 million each year. We use a similar formula to calculate the impact, as shown in Table 3.

[3] Capital spending ($662 million) is assumed to be construction (SIC 15) cost.

TABLE 3: Impact of University alumni in Illinois

	Output (million $)	Employment (thousand)	Income (million $)
Resources	171.55	4.56	61.13
Construction	430.66	5.56	175.09
Nondurables	3,364.14	11.26	486.70
Durables	2,497.94	11.23	490.14
Transportation, Communications, Utilities	1,602.24	10.08	411.63
Trade	2,959.24	48.49	1,058.31
Finance, Insurance, Real Estate	2,907.20	23.83	802.65
Services	7,114.19	147.23	3,494.64
Government	188.12	3.19	111.51
Total	**21,235.27**	**265.45**	**7,091.79**

	Output (million $)	Employment (thousand)	Income (million $)
Direct	6,686.60	109.71	2,571.50
Indirect	14,548.67	155.74	4,520.29
(Multiplier)	3.18	2.42	2.76

Note: Alumni's wage and salaries ($6,686.6 million[4]) are reallocated to each sector using household's consumption shares.

So the approximately $6.7 billion in alumni wages and salaries ripple through the economy, producing an additional $2.18 for each $1 spent, to add **just over $21.2 billion to the state's economic output.** Spending by alumni contributes to more than 265,000 jobs and adds more than $7 billion in income throughout the economy.

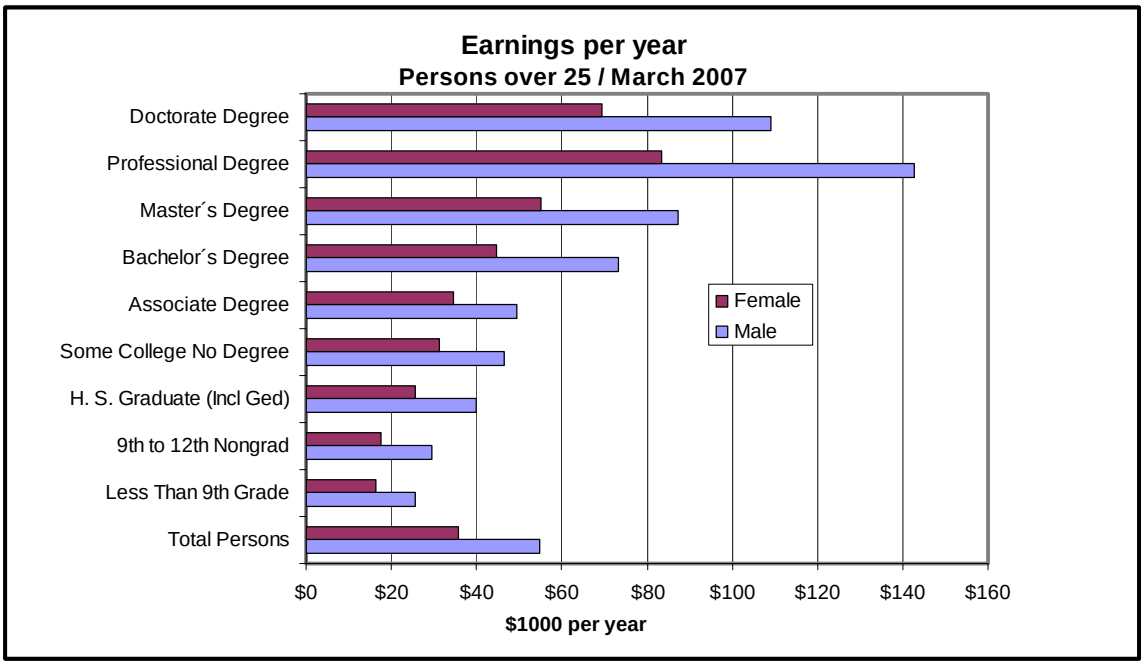
[4] $6,686.6 million = $55,794.84(average wage and salary, estimated) * 119,842 (total alumni in Illinois as of Oct. 2008)

Monetary Benefits to Students[5]

Students gain many things from attending college including a better understanding of the world, the capacity to achieve better health, a willingness to lead a better life style and a greater willingness to donate to worthy causes. But most believe the education they receive will give them better employment opportunities and eventually higher salaries. In this section we determine the expected average monetary gain to the student from his or her time in school and then find the total gain to students for all of the university's activities in a single year.

As we examine the salary levels of college graduates, we need to consider the income lost from alternative education as they attend school, as well as the fraction of their ultimate income that can be attributed to the college education as opposed to their natural ability. With all of these considerations, students receive a very large monetary gain from attending college.

The chart shows the average earnings of people with different levels of education. In each pair of bars, the first represents women and the second represents men.[6]



Two things stand out in this table. First, higher levels of education are in general associated with higher earnings. And second, at all levels of education, men earn more than women.

With this substantial increase in earnings we determine the expected annual differential earnings for each person, and then the present value of the stream of earnings.

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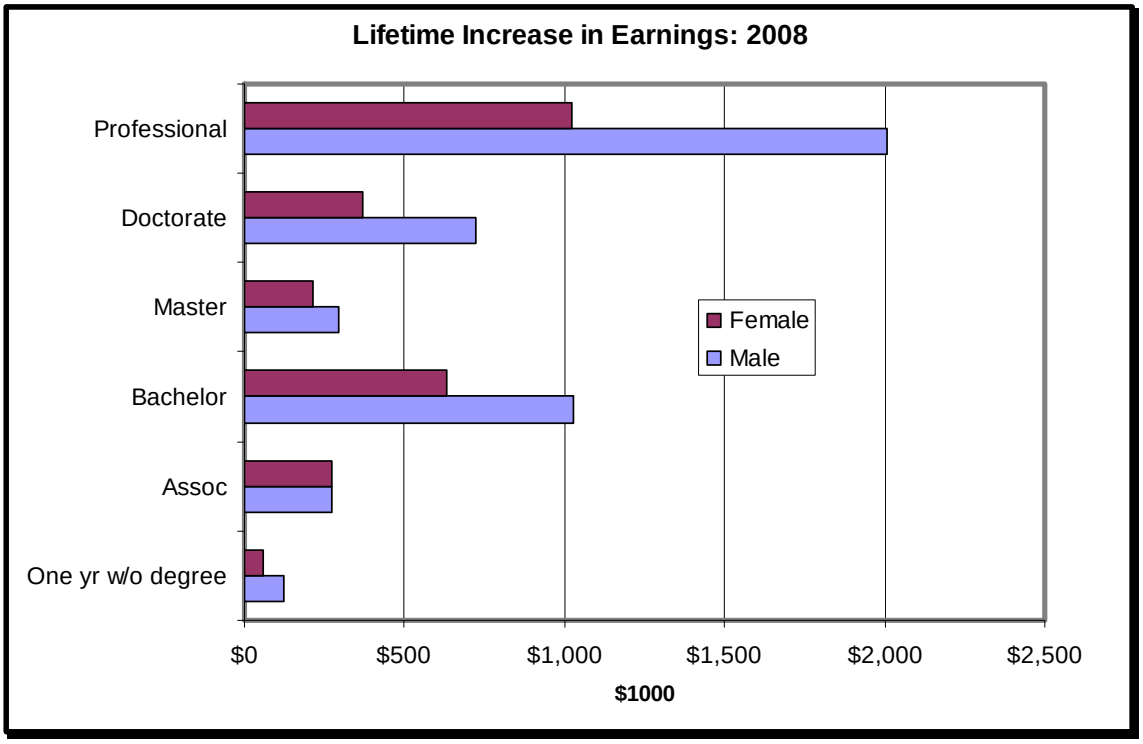
[5] This material is revised and updated from Robert W Resek, David Merriman, et al, *Illinois Higher Education: Building the Economy, Shaping Society*, IGPA, 2000.

[6] U.S. Census Bureau, Current Population Survey, 2008 Annual Social and Economic Supplement. 2007 CPS.xls / Table

Our value for increased earnings is based on a number of important factors including:

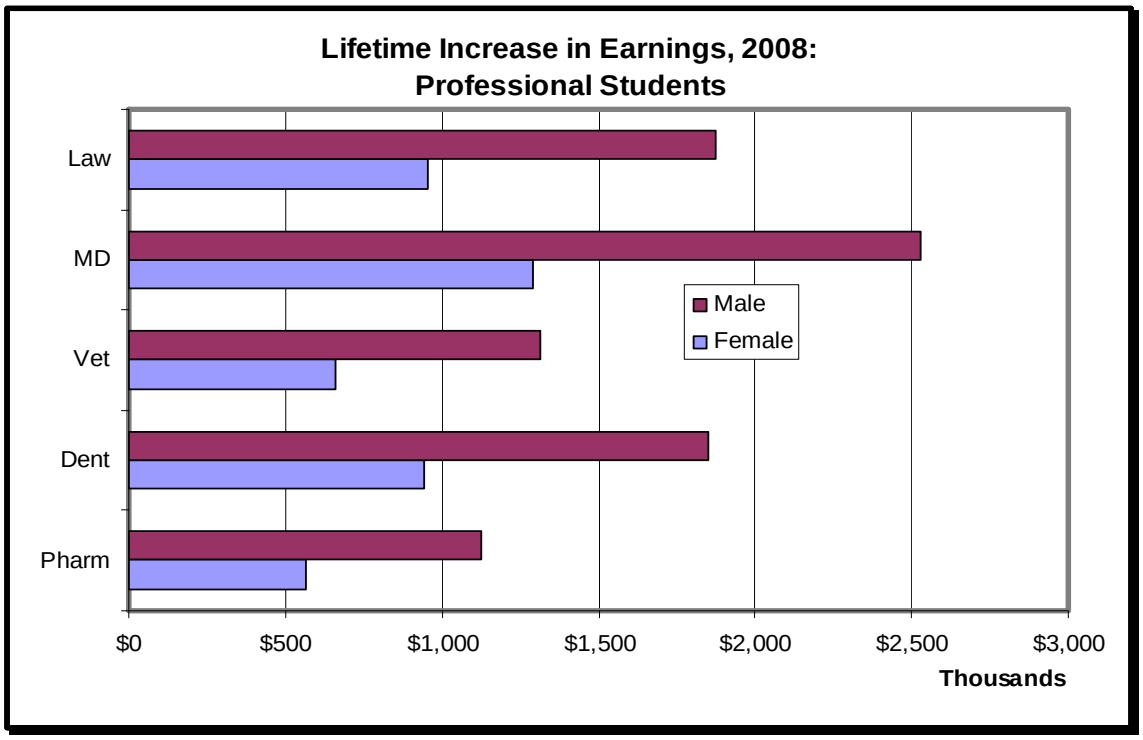
- The fraction of earnings that may be attributed to the college education (as contrasted with that associated with native intelligence)
- The age of the student when work life starts (older students have a shorter time to earn and therefore will have a smaller financial benefit)
- The expected work life of the student (the time when he or she would retire)
- The income lost while in school
- The discounted present value of earnings (how much would need to be invested to achieve the same return each year in the future)
- The value of future fringe benefits including retirement income.

The chart shows the increased total income (discounted to the present) for a student who earns an additional degree.[7]



As we expect from higher annual earnings of men relative to women, in our society, men gain more financially than women. The next chart subdivides the professional graduates into the specific degree.

[7] For each degree type, the income gain is the increase over the prior degree. Therefore, for a student who earns a professional degree the gain is the increment over the bachelor's degree. Cen earn 2008 1.xls / I Earnings



The greatest gain is for students who receive an MD, a gain $1.3 million if female and $2.5 million if male.

Enrollment and Graduates

The total gain to all students obviously depends on the number of enrolled students and the number of students who receive degrees. The University has a very large number of students and graduates. The first table shows the number of students enrolled in Fall 2008.[8]

Students, Fall 2008

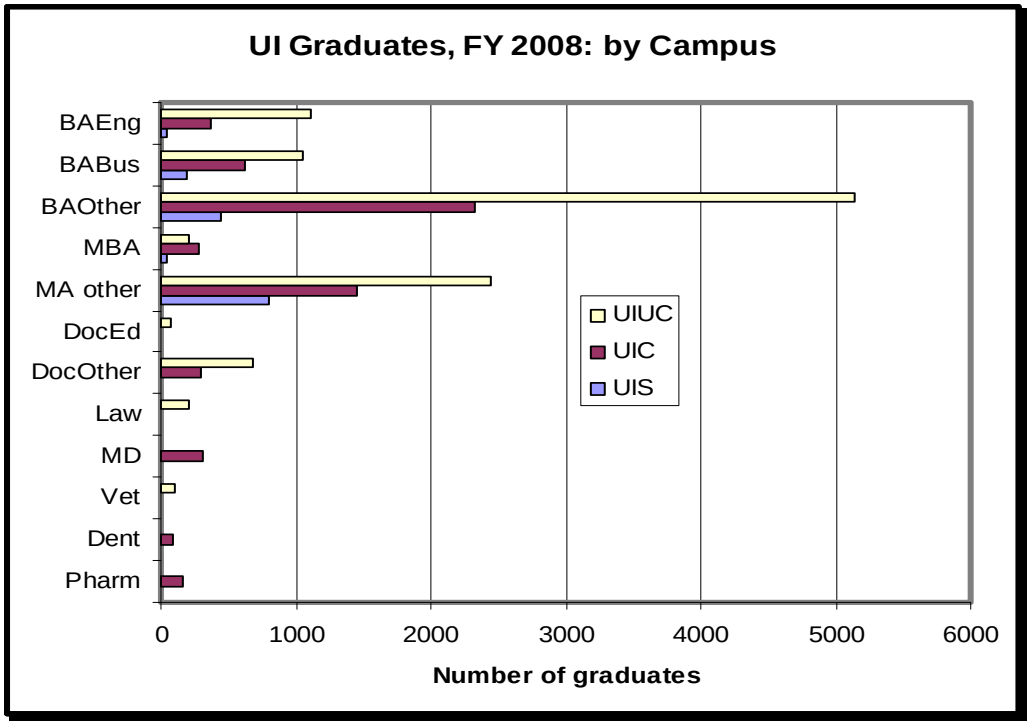
	Male	Female	Total
UIUC	22,974	20,272	43,246
UIC	11,549	14,286	25,835
UIS	2,085	2,626	4,711
Total	36,608	37,184	73,792

2008 value 2.xls / enroll data

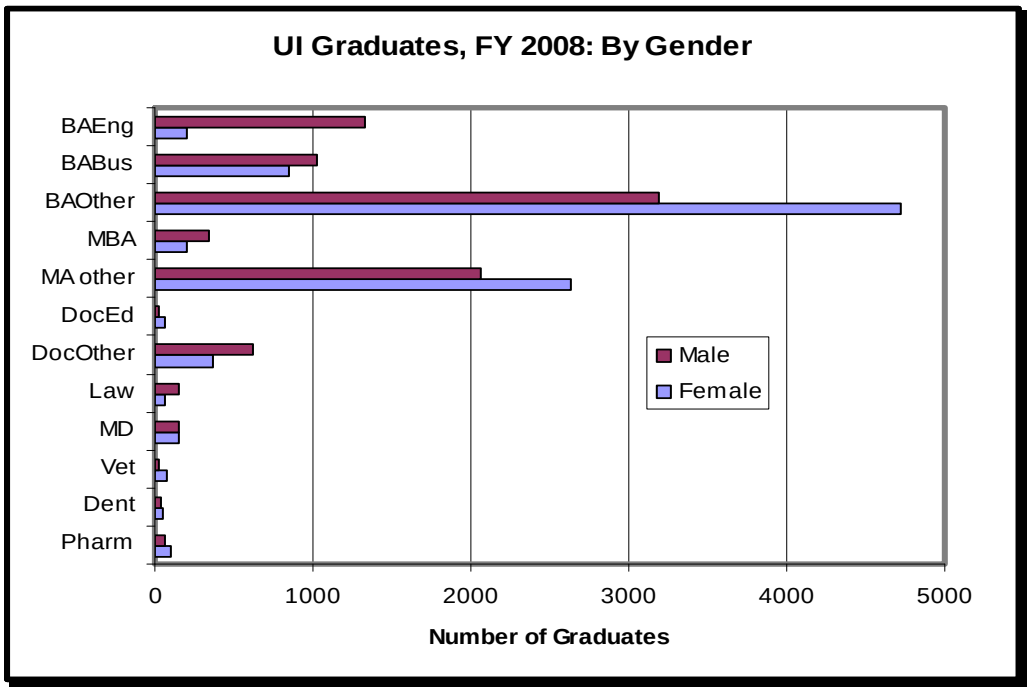
Among these students there are many who graduate each year. The next charts show the number of graduates.

[8] All enrollment and graduation data are from the UI Office of Planning and Budgeting. 2008 value 2.xls / enroll data

The actual total gain to all students is impacted by the total enrollment by type of degree as well as gender. It is apparent that, by far, most students receive bachelor's degrees and although many are in engineering or business, the vast majority are in other fields of endeavor. Throughout this analysis we combine computer and information science graduates with engineering and for convenience call the combination engineering.



It is interesting to note that the UIC campus has more MBA graduates than Urbana Champaign. Professional degrees are clearly specific to campuses.



It is also apparent from the chart above that the total number of women in the entire UI exceeds that of men, each campus has a larger share of men in engineering and business. And as shown below, Urbana campus has more men than women.

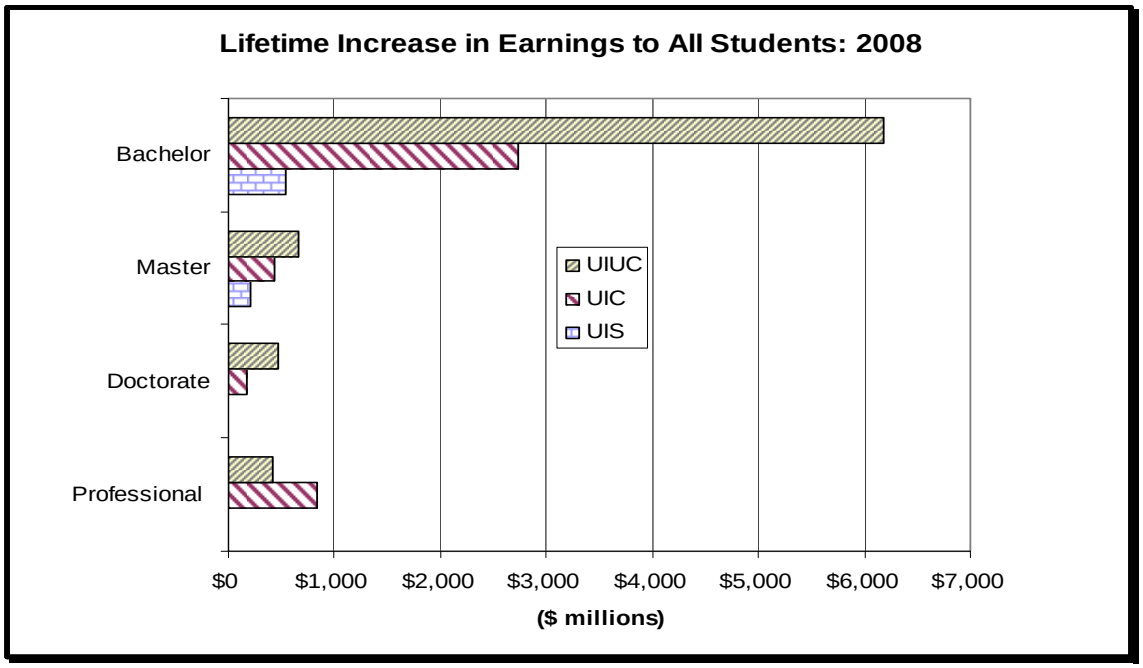
Total UI Graduates, FY 2008

	Male	Female	Total
UIUC	5706	5330	11036
UIC	2613	3325	5938
UIS	701	823	1524
Total	9020	9478	18498

Total Gain to All Graduates

As one considers all the graduates in a single year, we can find the total benefit to all the students from their time at the university.

First, we examine the benefits to students by the degree level, bachelors, masters, doctorate, or professional.



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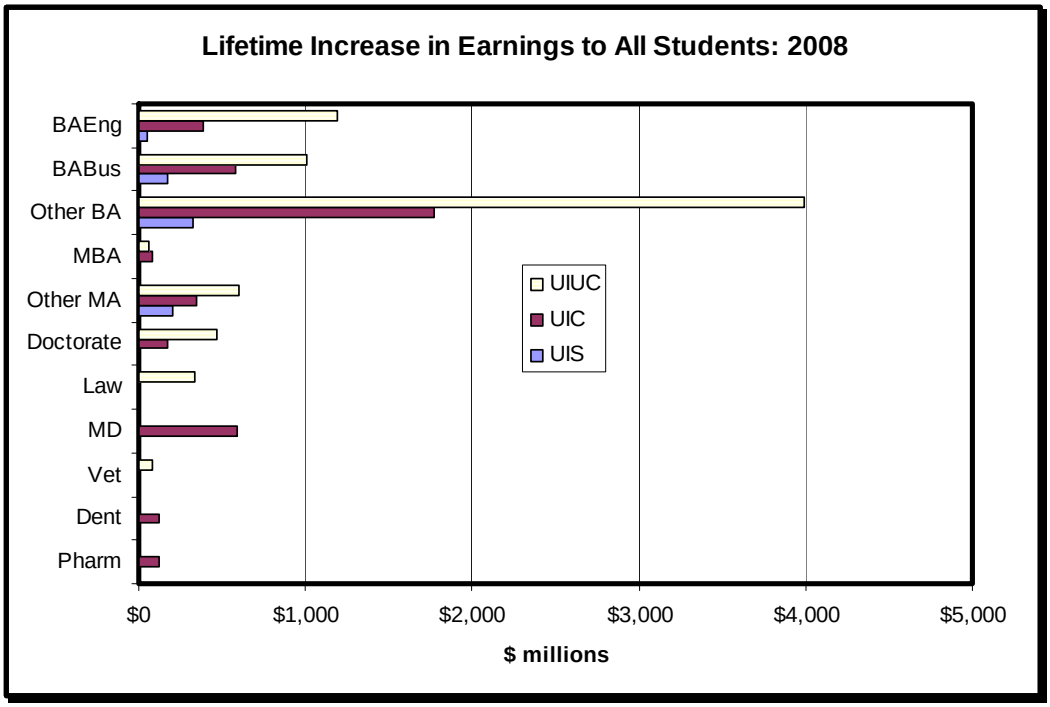
Bachelor's degree students at UIUC gain a total of $6.2 billion in a single year. The other income increases are similarly impressive and are seen in the chart. It is also interesting to examine a more detailed breakdown of the type of degree and the total benefits earned by the students.

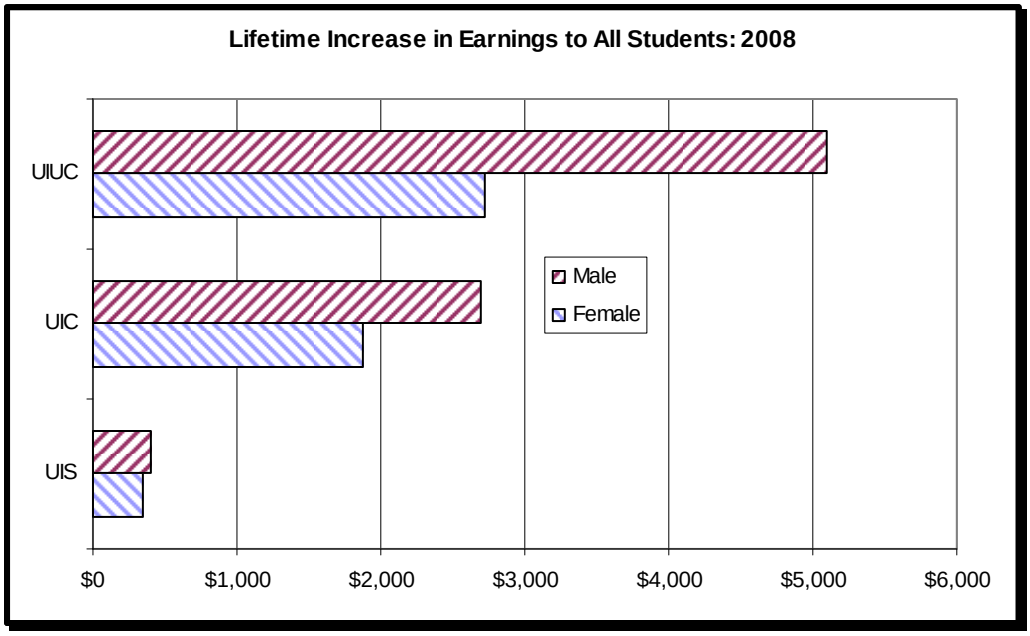


In this chart, we separate the value from the bachelor's degrees into three components: engineering degrees (including computer and information science), business degrees, and all other bachelors. Clearly all three campuses have a greater number of students in the latter category, but the engineering and business each make a significant contribution to the campus. For example, engineering students gain a total of $1.2 billion at Urbana-Champaign, $400 million at UIC, and the computer and information science students at UIS gain $50 million.

Master's degrees are divided into MBA and other Masters degrees since the MBA degree is of a different character than other master's degrees. Finally, the professional degrees are divided into their separate types. The MD degree has a greater total value to students both because there are more MD graduates than other professional degrees and because on the average the gain in future income to MD's is greater than other degrees.

Finally, we look at the benefits by campus to men and women separately. The higher benefits to men occur since over their lifetime men, on the average, earn more than women.

The chart and table below provide the incremental value that can be seen at the graduation ceremonies from all of the work of the students.[9]



[9] Some students transfer to other schools to complete their work and others transfer in. Therefore, our final values are corrected for these changes.

Lifetime Increase in Earnings to All Students, 2008
(millions)

	Female	Male	Total
UIUC	$ 2,723	$ 5,092	$ 7,815
UIC	$ 1,881	$ 2,693	$ 4,573
UIS	$ 345	$ 396	$ 741
Total	$ 4,948	$ 8,181	$ 13,129

In total students at the University of Illinois gain $13.129 billion dollars each year. This is an impressive contribution to our state and nation.

INCREMENTAL STATE AND LOCAL TAX REVENUE FROM U OF I STUDENTS

As we have shown, students in Illinois benefit directly from very large increases in their income as a result of attending school in Illinois. This income leads to similar gains for state and local government. The students who live in Illinois will pay income tax as well as sales tax on items they purchase. Moreover, they will pay property taxes within the state as well as taxes on gasoline, telephone, electricity and so forth. The companies they work for will be more profitable as a result of their efforts, and they, too, will pay additional taxes. Just as the income continues over the working life of the students, the tax revenue will also occur over many years in the future. Therefore we determine the present value of the future taxes that will be paid by these students and received by Illinois governments.

We include both state and local tax revenues and exclude from consideration federal tax revenue. Several taxes are considered.[10]

SALES TAXES

This tax covers only a subset of all sales in the state so the tax rate does not tell us what the average consumer spends on sales taxes. Because of this, we examined the total sales tax collections in the state and found that these are 1.96 percent of state personal income. In addition, we analyzed data for the counties in Illinois to find the degree to which additional income adds to spending on these taxes. This work found a sales tax elasticity of 1.15. Each additional $100 of income therefore increases tax revenue by the average taxation times the elasticity or $2.25. In this analysis, we include the local government share of the state sales tax but exclude locally determined sales taxes.

[10] Data Sources: State of Illinois Office of the Comptroller:
http://www.revenue.state.il.us/publications/AnnualReport/2006/2006table1.pdf.
National Tax Foundation for Property Taxes: http://www.taxfoundation.org/publications/show/1913.html.
Bureau of Economic Analysis for Personal Income: http://www.bea.gov/regional/spi/.

PERSONAL INCOME TAXES

The students' additional income will directly increase the income reported to the state on tax returns. Since the state allows limited deductions, the added income resulting from higher education will be taxed at the 3 percent marginal rate. This additional income will also appear on federal income tax returns, resulting in a substantial benefit for the U.S. government which we will not calculate here.

CORPORATE INCOME TAXES

While we believe that corporate taxes will rise more than proportionally as incomes rise, we have no information on which to base an estimate of this effect. Therefore, we limit our corporate tax increment to the average ratio of corporate taxes to state personal income, 0.61 percent.

MOTOR FUEL TAXES

As with corporate income taxes, our information is limited to the average motor fuel tax collections in proportion to state personal income, 0.30 percent.

OTHER STATE TAXES

The largest element within this category of "other" taxes is the public utility tax, but it also includes cigarette, inheritance, corporate franchise, liquor, and riverboat taxes. We limit this analysis to taxes that would be expected to rise with income. This category totals 0.70 percent of personal income.

PROPERTY TAXES

We found the average property tax rate in relation to income, 4.76 percent, and adjusted this by the income elasticity of property tax revenue, 141 percent. The outcome is that, on average, each additional $100 of income leads to an additional $6.72 in property taxes.

OTHER LOCAL TAXES

A number of other taxes are collected by the state for local governments including soft drink taxes, and auto renting taxes. We employ these at the average rate or 0.47 percent.

FUTURE TAX REVENUE

The total incremental tax sources amounts to 14.05 percent of the increase in graduates' income. However, because only the students that stay in Illinois pay these taxes, we reduced the revenue by the fraction of students that live outside of Illinois after graduation.[11] Our analysis shows that 68.4 percent of alumni live in state. Based on these facts, the table shows the future tax revenue for the separate campuses and the total university from each type of tax. The state's governments receive $1.261 billion dollars for each year the university educates its students.

[11] Survey by Institute of Government and Public Affairs, University of Illinois.

PRESENT VALUE OF FUTURE TAX REVENUE

		Future Tax Revenue ($ millions)			
	Marginal Tax Rate	UIUC	UIC	UIS	Total UI
Sales Tax	2.25%	$120.0	$70.2	$11.4	$201.7
Personal Income Tax	3.00%	$160.4	$93.8	$15.2	$269.4
Corporate Income Tax	0.61%	$32.9	$19.2	$3.1	$55.2
Motor Fuel Tax	0.30%	$15.8	$9.2	$1.5	$26.6
Other State Taxes	0.70%	$37.6	$22.0	$3.6	$63.1
Property Tax	6.72%	$359.0	$210.1	$34.1	$603.2
Other Local Taxes	0.47%	$25.1	$14.7	$2.4	$42.2
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Total	14.05%	$750.8	$439.3	$71.2	$1,261.3

FUTURE REVENUE COMPARED TO STATE'S INVESTMENT IN THE UNIVERSITY

The future gain to the state can be compared with the state's appropriation. In FY 2008, the total state appropriation was $726 million. The table below shows this allocated to campuses and compared with the future tax revenue from that campus.

	UIUC	UIC	UIS	Total
Future Tax Revenue	$750.8	$439.3	$71.2	$1,261.3
State Appropriation	$335.5	$375.4	$15.1	$726.0
Gain from Student's Income	$415.3	$63.9	$56.1	$535.3

The annual activity of the University of Illinois in educating students and awarding degrees creates $1.261 billion dollars of future revenue for the state but only costs $726 million in appropriations. The gain of $535 million shows how the university is a great financial investment for the state.

NONMONETARY RETURNS TO THE STUDENT AND SOCIETY[12]

Researchers who undertake a study of the returns to higher education usually emphasize the monetary returns, which are enormous and measurable. Expenditures on education are clearly an investment; parents, students, governments, and employers spend money on education now with the expectation of financial returns in the future. However, education has substantial impacts outside the financial market. Individuals and society benefit from education in ways that are less tangible and more difficult to measure, but are no less substantial. As stated by Haveman and Wolfe, "A full accounting must consider all of schooling's effects, positive and negative, and not simply those recorded in a single market."[13]

Therefore, our study would be remiss by not mentioning the non-financial returns which accrue to the individual and to society. Personal development, preservation of the cultural heritage, advancement of knowledge and art and literature, national prestige and power, and the satisfaction of living in an educated society are all benefits of education. "These nonmonetary benefits surely are far greater than the monetary benefits—so much greater, in fact, that individual and social decisions about the future of higher education should be made primarily on the basis of nonmonetary considerations and only secondarily on the basis of monetary factors."[14] This is perhaps too idealistic a sentiment, but clearly the expected nonmonetary benefits are worth considering when making decisions regarding higher education.

CAVEATS

Several caveats should be noted in our analysis. First, our study should control for income and not include elements that could be caused by either income or education. Our main results are based on studies that controlled as appropriate for income, age, and race.

Second, it is not appropriate to assume that all of the nonmonetary benefits discussed below are cumulative in their effects. Each effect was verified independently of the others, and many or most may actually represent different ways of looking at the same educational benefit. In addition, the research on each nonmonetary benefit generally focused on a specific population, such as adults aged 25 to 64, or young black females in New Jersey. We have included mention of every nonmonetary benefit we found, but the level at which the studies were done may render the results more applicable to some regions and populations than others.

Third, college education clearly has great benefits for individuals, families, and society, apart from the effects of increased income. However, the direction of causality is not always clear. In our analysis of monetary gains to students, we used results from the Ashenfelter-Rouse

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[12] This section is updated and amended to related specifically to the University of Illinois from, Robert W Resek , David F Merriman, et.al., *Illinois Higher Education: Building the Economy, Shaping Society,* 2000, Institute of Government and Public Affairs and the Illinois Board of Higher Education. That publication provides the source of all of the results.

[13] Robert H. Haveman and Barbara L. Wolfe, "Schooling and Economic Well-Being: The Role of Non-Market Effects," *The Journal of Human Resources*, vol. 19, no. 3, Summer 1984, p. 379.

[14] Howard R. Bowen, *Investment in Learning: The Individual and Social Value of American Higher Education,* Baltimore: The Johns Hopkins University Press, 1997.

study of twins that indicated the amount of change caused by the college education. While these results do not apply directly to nonmonetary gains, as an estimate we have used the same 88 percent adjustment factor. Therefore, we may have over- or underestimated the true causation.

SPECIFIC BENEFITS

In our analysis of monetary benefits to students, we found the specific dollar increment of income that is received by Illinois students from one year's activity by Illinois higher education. In that section we found an annual change in income for each student and then calculated the present value of all future income.

As above, we consider the effects of one year's activity by Illinois higher education. However, we cannot calculate the present value of nonmonetary outcomes, so instead we take an historical approach and determine the benefits that Illinois enjoys in the current year as a result of past Illinois higher education activities.

The impact this history creates in a single year from the University of Illinois:

- 2250 fewer premature adult deaths
- 85,000 more members of the labor force
- 90,000 more employed people
- 130,000 more people volunteering their time
- 650,000 more volunteered hours each week
  (equivalent to 16,500 full-time jobs worth of volunteer work)
- 75,000 more people giving to charity
- $350 million more in charitable contributions
- 100,000 more registered voters
- 115,000 more people voting in major elections

GENERAL BENEFITS

The most obvious nonmonetary benefit of higher education is that the student becomes educated. In school, people learn information and skills that will serve them in their careers and in their social lives. Liberal arts and humanities students seek a broad-based education covering literature, arts, and philosophy, which will make them better conversationalists, thinkers, and leaders. Those who study sciences such as engineering or chemistry will become better engineers and chemists, with the hope that their work and research will improve the way of life for people.

There also exist a number of nonmonetary benefits that cannot be quantified as directly as those described above. The following listing delineates a number of these.

THE NONMONETARY BENEFITS OF A COLLEGE EDUCATION

People with some college education:

Health

- have better health, as do their families
- have lower mortality rates, and have children with lower mortality rates
- are more likely to seek prenatal care when they become pregnant
- are less likely to smoke cigarettes when they become mothers

Child rearing and domestic management

- have daughters who are less likely to give birth out of wedlock
- are better at family planning and using contraceptives
- become more actively involved in their children's education
- are more likely to provide a quality education for their children
- read more to their children on a daily basis
- have children with higher education levels and better cognitive development
- are more skillful in making household purchasing decisions, thereby saving money and improving health and safety
- tend to have a higher savings rate
- rely less on public financial aid

Employment

- have reduced job search costs and are more regionally mobile with respect to work location
- tend to have better working conditions, including health and safety of the workplace, flexible work schedules, work autonomy, and grievance procedures
- tend to find their work more enjoyable, interesting, and challenging

Participation in society

- donate more time and money to charitable causes
- are more likely to vote
- are less likely to participate in criminal activity
- are less likely to receive welfare or Social Security disability benefits

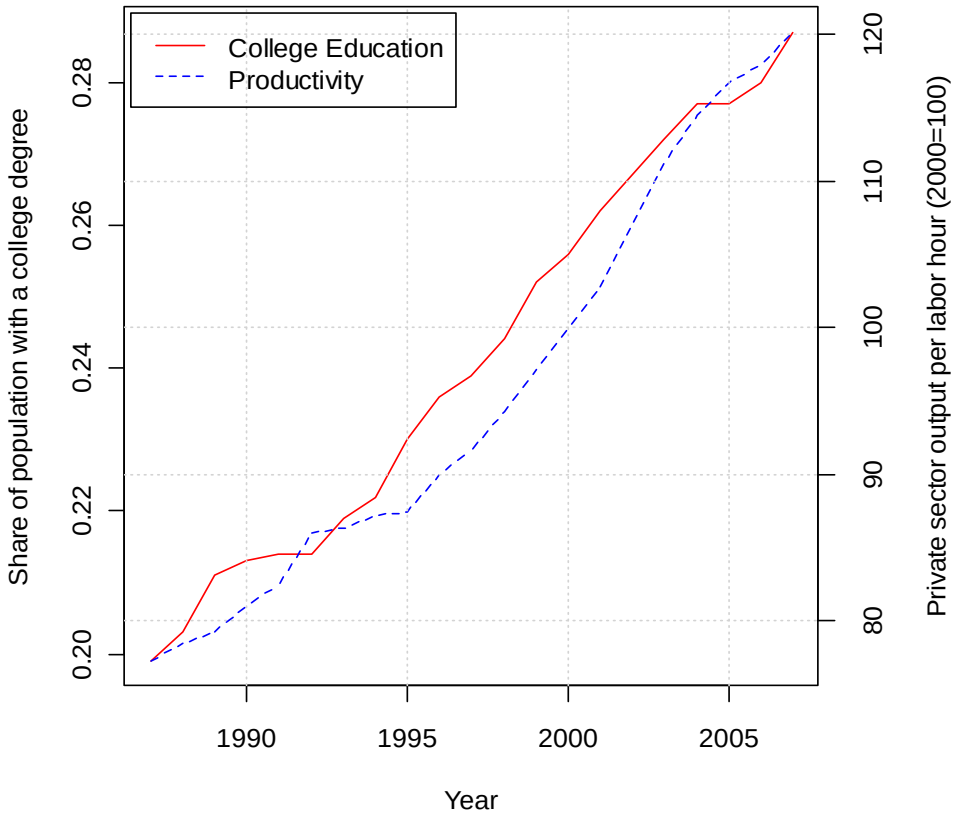
Just as the monetary benefits aid students and the tax receipts aid governments, the nonmonetary benefits discussed here are of great importance to our society.

The Productivity Effects of Higher Education

Productivity growth is the primary means by which we, as a nation, raise our standard of living and higher education is one of the most effective means to increase productivity. The goods and services we consume are produced by combining labor, capital and other inputs. Productivity is the measure of how much output is produced per unit of input. Our economy is more productive when we are able to produce more output with the same level of inputs (or produce the same output using fewer inputs). The two most widely-used measures of national productivity are labor productivity, which is total output of all goods and services per hour of labor input, and multifactor productivity, which is total output relative to labor, capital and any other inputs used in production.

Aggregate educational attainment and aggregate labor productivity are intimately linked. Figure 1 below shows the share of the working age population (those 25 to 64) with a college degree from 1987 to 2007; along with an index of national labor productivity (labor productivity in 2000 is normalized to be 100). It is clear that both series are trending upward together. Over the past two decades, labor productivity increased by 55 percent. Some of this increase is due to rising educational attainment, as the share of the population with a college degree rose from 19.9 percent to 28.7 percent during these twenty years, an increase of 44 percent.

Figure 1: Labor productivity and the share of the population with a college degree, 1987-2007

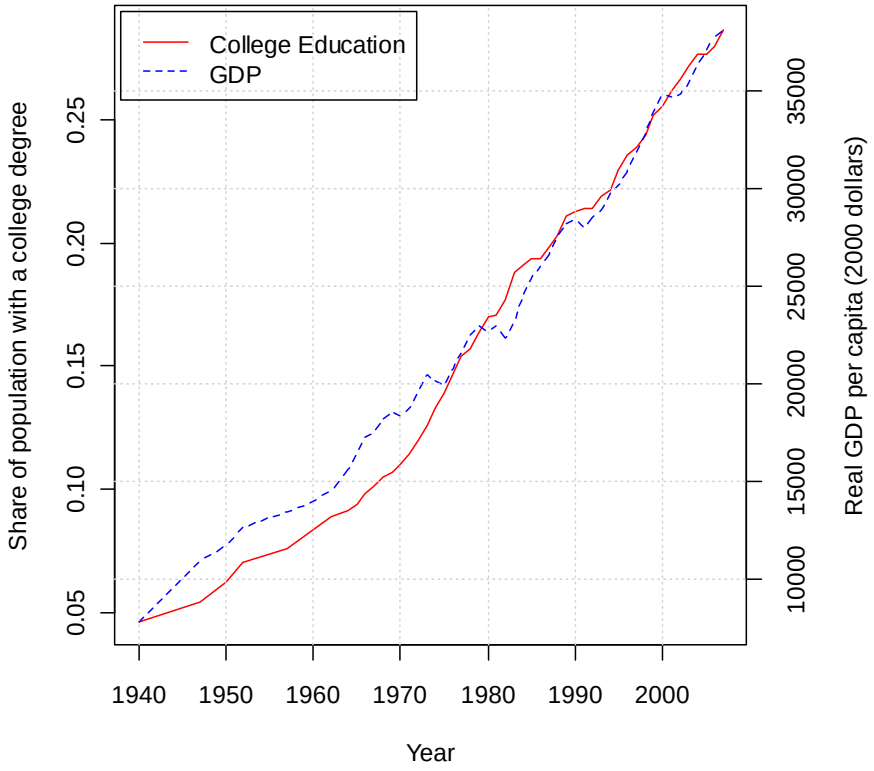


Note: Educational attainment data refer to individuals aged 25 and older.

Sources: Educational attainment data are from the Current Population Survey (various years), tabulated by the U.S. Census Bureau. See http://www.census.gov/population/socdemo/education/cps2007/tabA-2.xls. Productivity data is from the Bureau of Labor Statistics.

The national trends in education and labor productivity also translate into growth in national income. Figure 2 shows the longer-run trend from 1940 to 2007 in the fraction of the work force with a college degree and inflation-adjusted per capita GDP. During this period, real per capita income rose nearly five-fold, from $7,827 to $38,148. The fraction of the population with a college degree rose from 4.6 percent to 28.7 percent.

Figure 2: Real per-capita GDP and the share of the population with a college degree 1940-2007

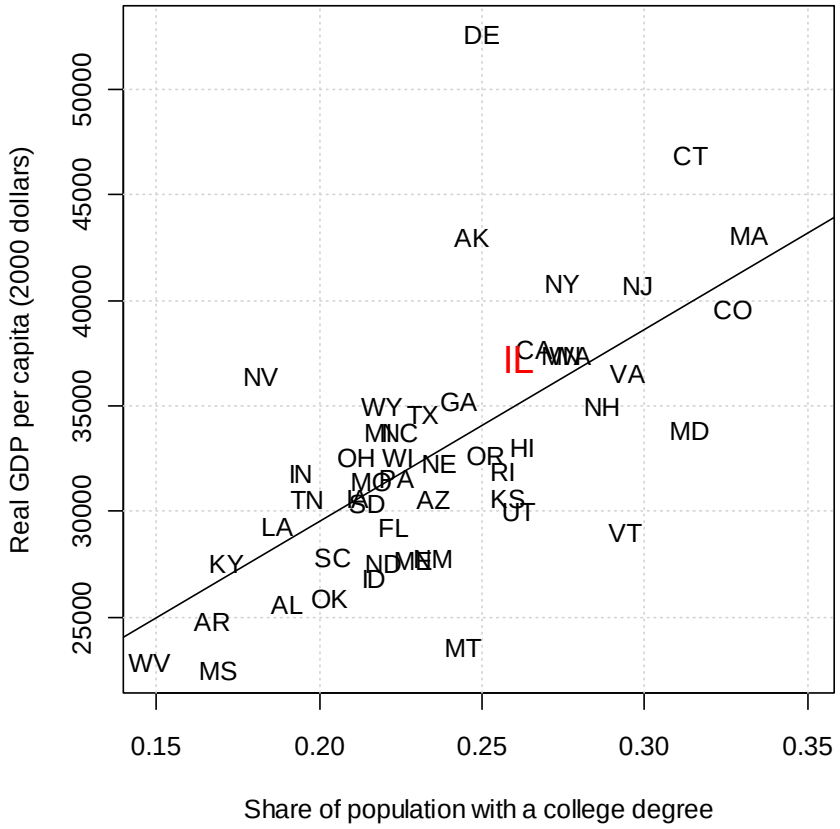


Notes: Educational attainment data refer to individuals aged 25 and older.

Sources: Educational attainment data are from the Current Population Survey (various years), tabulated by the U.S. Census Bureau. See http://www.census.gov/population/socdemo/education/cps2007/tabA-2.xls. GDP data are from the Bureau of Economic Analysis, U.S. Department of Commerce. See http://www.bea.gov/national/Index.htm.

The strong relationship between education and income is also evident across states at a point in time. Figure 3 shows a scatter plot of data from the 2000 decennial census on the fraction of a state population with a college degree and statewide average income. (Illinois is highlighted in red.) Variation in college graduation rates accounts for 41 percent of the variation in per capita income across states. Although there is some variation around the fitted regression line, the data indicate that each additional percentage point of the population with a college degree is associated with an increase in average annual per capita income of $911. Put differently, 29.8 percent of New Jersey residents have a college degree, compared to only 26.1 percent of Illinois residents. This 3.7 percentage point difference is predicted to translate into a difference in per capita income of 3.7 times $911, or $3,371. The actual income difference is $40,895 minus $37,317, or $3,578. Most of the difference in income reflects differences in educational attainment.

Figure 3: Per-capita state GDP and the share of the population with a college degree,



Notes: Educational attainment data refer to individuals aged 25 and older.

Sources: Educational attainment data are from the 2000 decennial Census. See http://www.census.gov/prod/2003pubs/c2kbr-24.pdf. State GDP data are from the Bureau of Economic Analysis, U.S. Department of Commerce. See http://www.bea.gov/regional/gsp/.

Education may raise productivity for a number of reasons. Most importantly, education improves individuals' skill and increases the quantity or quality that individuals can produce in a given time. Higher skilled workers also create new technologies that allow our existing stock of labor to produce more or better products and services. A growing body of research also indicates that higher educated workers increase the productivity of other workers around them. Finally, universities are major producers of basic research – research that forms the foundation for future advancements in technology. The following sections expand on these themes.

Education and individual productivity

Education enhances both general and specific skills. General skills are those that are applicable to a wide range of tasks – skills such as writing, critical thinking, and math. General skills may also make it easier for an individual to learn more specific skills. Specific skills are

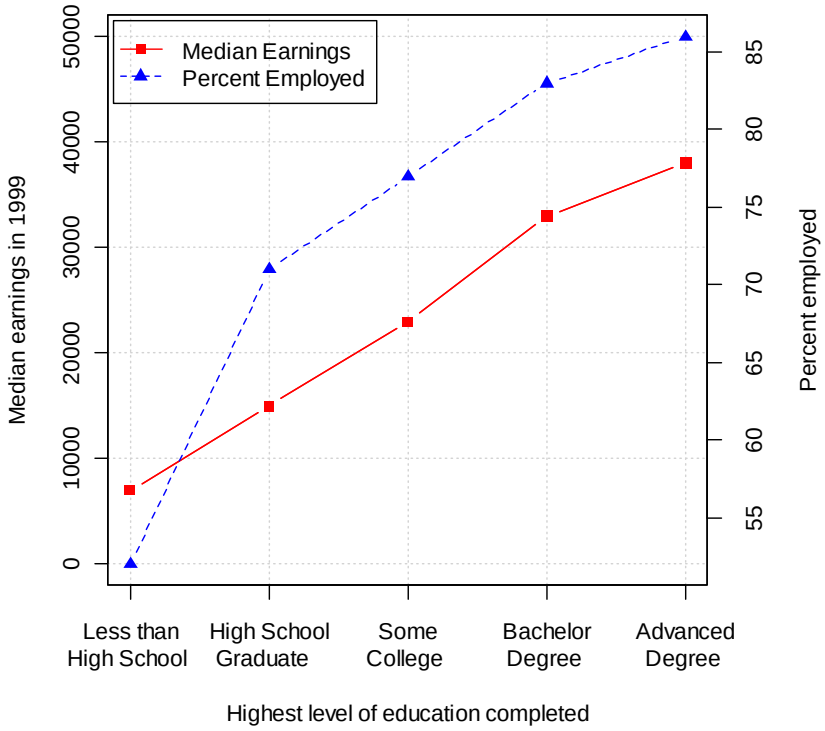
those applicable to a particular task, job, or firm – skills such as writing a financial report, preparing a legal brief, or operating a specific type of machinery. Higher education tends to develop general skills and knowledge, but some programs (such as engineering) also develop specific skills. Graduate programs tend to develop more specific skills. Both general and specific skills may enable workers to better develop on-the-job skills, which tend to be highly specific to a firm or industry.

While aggregate data and economic theory both suggest a strong effect of education on productivity, demonstrating and measuring this effect at the individual level is not simple. An important stumbling block for researchers is that many people work in teams where it is difficult to assess each member's contribution to overall productivity, or produce goods and services where it is difficult to accurately measure quantity or quality. Rather than measure the relationship between education and productivity directly, most researchers measure the relationship between education and earnings. This makes sense because standard economic models predict that wages will be roughly equal to productivity in private sector, for-profit firms.[15]

Figure 4 shows data from the 2000 decennial census on median earnings among individuals with different levels of education. In these data, median earnings among individuals with only a high school degree were $27,351. Median earnings among those with a college degree were $42,877, 56.8 percent higher. The figure also shows noticeable differences in employment rates by educational attainment. The employment-population ratio is 71 percent among high school graduates and is 83 percent among college graduates.

[15] See John Pencavel (1991), "Higher Education, Productivity, and Earnings: A Review," *Journal of Economic Education*, Volume 22, Number 4, pp. 331-359.

Figure 4: Median earnings among full-time/full-year workers and employment rates by educational attainment, 1999



Notes: Earnings data refer to individuals aged 21 to 64 who worked 50 weeks or more and 35 or more hours per week in 1999. Employment data refer to individuals aged 21 to 64.

Sources: Data are from the 2000 decennial Census. See http://www.census.gov/hhes/www/income/earnings/call1usboth.html.

The earnings premium from attending college has increased noticeably over the past thirty years. While college graduates today earn 56.8 percent more than high school graduates, in 1980 college graduates only earned about 20 percent more.[16] While there are many factors that contributed to this historic increase in the return to education, one important factor is the development of new information technologies that are complementary to workers skills. This phenomenon is referred to as "skill-biased technological change" and refers to the idea that new technology has increased firms' relative demand for high-skilled workers, resulting in bidding up of their wage rates.[17]

[16] Authors' tabulation of the 1981 March Current Population Survey, which records annual earnings from 1980.

[17] A recent statement of this view is in David H. Autor, Lawrence F. Katz, and Melissa S. Kearney (2008), "Trends in U.S. Wage Inequality: Revising the Revisionists," *Review of Economics and Statistics*, Volume 90, Number 2 (May), pp. 300-323. An alternative view is expressed is David Card and John E. DiNardo (2002), "Skill-Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles," *Journal of Labor Economics*, Volume 20 (October), pp. 733–783.

A major difficulty in assessing the causal effect of education on earnings is that higher ability people may choose to stay in school longer. This means that the simple relationship illustrated in Figure 4 between education and earnings reflects both the productivity-enhancing effect of schooling, as well as the fact that people who go to college probably would have had higher earnings than the typical high school graduate even if they had stopped their schooling after high school graduation. A key to untangling these two factors is finding a source of variation in schooling throughout the population that is plausibly unrelated to individuals' underlying abilities. A flurry of research over the past twenty years has explored this issue, using novel strategies such as comparing the earnings differences between identical twins with different levels of education, comparing the earnings of people who live in places with different compulsory schooling laws, or comparing people who live closer to a university with those who live further and are less likely to attend.[18] Surprisingly to many researchers, studies that attempt to carefully measure the causal effect of education tend to find that the rate of return is quite similar to that suggested by simple comparisons of earnings that do not take into account the supposed higher ability of those who choose to stay in school longer.

Social returns to education

Highly educated individuals do not simply increase their own productivity and earnings, but likely also affect the productivity of those around them. These social effects could take many forms: highly-skilled individuals are more likely to generate new technology that is used by everyone, workers learn directly from their highly-skilled coworkers, or high-skilled managers are able better match workers to tasks and thereby increase overall productivity, to give a few examples.

These spillovers from education are important to understand. Most people make decisions about how long to stay in school on the basis of the higher wages and other benefits that accrue to them, relative to the costs they bear. If spillovers from education are large, then the benefits to the society at large are greater than an individual's private benefit. As a result, some people may choose to stop their schooling at a point when the social benefit from additional education is greater than the additional cost. These spillover effects are an important justification for public subsidies to education.

Recent research indicates the social returns to education exceed the private returns. In a series of papers, Enrico Moretti argues that firms tend to be more productive in cities that have a better-educated work force, and workers in these cities tend to earn more than similarly educated workers who live in cities with lower overall education.[19] He follows a sample of

[18] This literature is summarized and assessed in David Card (1999), "The Causal Effect of Education on Earnings," in Orley Ashenfelter and David Card (eds.), *Handbook of Labor Economics*, Volume 3, Chapter 30, pp. 1801-1863 Elsevier.
[19] This literature is summarized in Enrico Moretti (2004a), "Human Capital Externalities in Cities," in V. Henderson and J.F. Thisse (eds.) *Handbook of Urban and Regional Economics*, Volume 4, Chapter 51. North Holland-Elsevier.

manufacturing plants between 1982 and 1992 and finds that, holding constant the skill level of workers at the firm, firms located in cities that experienced an increase of one percentage point in the share of the population with a college degree tended to experience an increase in output of about 0.5 to 0.6 percentage points.[20] Moretti also finds that an increase of one percentage point in the supply of college educated workers to a city raises the earnings of workers with only a high school degree by 1.6 percentage points, and the earnings of those with a college degree by 0.4 percentage points.[21]

The social returns to education may also exceed the private returns because better educated individuals tend to be healthier (and thus reduce the net cost of government health programs), commit less crime, and be more engaged citizens.[22] These effects do not necessarily lead to enhanced productivity, though they do indicate additional channels through which an individual's own educational attainment influences the well-being of others.

Universities and the generation of basic research

A critical avenue through which institutions of higher education enhance productivity is the provision of basic research. Faculty and students conduct research that in many cases would not have been undertaken by individuals in the private sector. The results of this research are generally widely available for others to expand on, and also provide a foundation for further development and use by private firms. Recognition of this role of the university is not new. The Hatch Act of 1887 provided federal funds for the express intention of conducting and disseminating agricultural basic research by the land grant universities. Since then, universities have increasingly conducted basic research that has increased productivity thorough a wide variety of applications.

The distinguishing aspect of basic, or pure, research is that it is undertaken for the advancement of knowledge, and not necessarily with a specific application in mind. It seeks to explain fundamental ideas and often leads to future applied research. Because of its nature, direct applications are typically unforeseen. A useful illustration of basic research and subsequent unforeseen applications is the Nobel Prize-winning work of John Bardeen, Leon Cooper and John Schrieffer on superconductivity.[23] In the late 1950s, while at the University of Illinois, they developed a theory that explained at the microscopic level the property of certain materials to have zero electrical resistance at extremely low temperatures. Their work led to

[20] Enrico Moretti (2004b), "Workers' Education, Spillovers and Productivity: Evidence from Plant-Level Production Functions," *American Economic Review*, Volume 94, Number 3 (June), pp. 656-690.
[21] Enrico Moretti (2004c), "Estimating the Social Return to Higher Education: Evidence From Cross-Sectional and Longitudinal Data," *Journal of Econometrics*, Volume 121, Issues 1-2, pp. 175-212.
[22] See Kevin Milligan, Enrico Moretti, and Philip Oreopoulos (2004), "Does Education Improve Citizenship? Evidence from the United States and the United Kingdom," *Journal of Public Economics*, Volume 88, Issues 9-10, pp. 1667– 1695; Thomas Dee (2004), "Are There Civic Returns to Education?" *Journal of Public Economics*, Volume 88, Issues 9-10, pp. 1697–1720; and Moretti (2004a).
[23] See Lillian, Hoddeson and Vicki Daitch (2002), *True Genius: The Life and Science of John Bardeen*, Washington, D.C.: Joseph Henry Press.

additional pure and applied research on superconductivity, as well as diverse applications such as MRIs, digital circuits, and cellular receiving towers.

Private-sector firms generally do not have an incentive to conduct basic research. The time frame from research discovery to application is often long and uncertain, making the return on research investment difficult to calculate. Eventual applications that stem from basic research may not be related to a firm's business area, or may be easily duplicated by competing firms who did not bear the expense of the research. Universities therefore fill a crucial role in the development of research because they are able to take a more long-term view of the benefits of basic research and do not face the problem that competing firms will benefit without paying the costs to fund research.

The economic literature on basic research has generally taken two forms. One approach is to conduct case studies of individual university research results, and trace in detail how they impact private sector development. For example, John Martin and Benjamin Irvine describe the development of new products from radio astronomy research.[24] Jan Youtie and Philip Shapira consider the case of Georgia Institute of Technology and trace how faculty research has been utilized in the private sector.[25]

These studies can be informative because they demonstrate specific cases where basic research has produced downstream benefits. Unfortunately, it is difficult to make generalization from these types of studies because they are focused on a few highly successful examples. It is unclear if these examples are representative of the relationship between university research and productivity, or if they are exceptional cases that do not reflect a more general relationship.

An alternative approach is to study the spatial diffusion of research. This approach attempts to determine if higher levels of university research lead to increased innovation (introduction of new products) by local firms. One study in this literature by former University of Illinois professor Luc Anselin and colleagues examines university research and innovation in the technology sector.[26] They consider 125 metropolitan areas and construct several indices that measure the local coincidence of university research and private innovation. Their results indicate that university research directly impacts private sector innovation, as well as affects it indirectly through increased private-sector research.

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[24] B.R. Martin and J. Irvine (1981), "Spin-off from Basic Science: the Case of Radio Astronomy," *Physics in Technology*, Volume 12, pp. 204–212

[25] Jan Youtie and Philip Shapira (2008) "Building an Innovation Hub: A Case Study of the Transformation of University Roles in Regional Technological and Economic Development." *Research Policy*, Volume 37, Number 8, pp. 1188-1204.

[26] L. Anselin, A. Varga, and Z. J. Acs (1997). "Local Geographic Spillovers between University Research and High Technology Innovations," *Journal of Urban Economics*, Volume 42, pp. 422-448.

This approach has its own difficulties. By design, it can only measure the local spillover of university research. It cannot measure the impact of basic research in other locations. Another difficulty lies in measuring research and innovation. A variety of different proxies have been used, each with its own advantages and disadvantages. For university research the most common proxies are faculty publications, citations and grants; for private firms they are patents, research spending and new products. As a result, the magnitude of the impact of university research varies. Still, the majority of studies find that university research has a significant positive effect on local private-sector innovation.[27]

Conclusions

Our review of available evidence indicates a strong link between educational attainment and productivity. The most direct link, and that which the evidence is most clear, is that education raises an individual's own skill level. Recent research also points to a positive spillover effect that highly educated individuals have on others. The modern research university generates both skilled graduates and faculty research. While it is difficult to precisely quantify the level and impact of research on national productivity, the effects seem certain to be large.

[27] For a review of this literature, see Ammon J. Salter and Ben R. Martin (2001), "The Economic Benefits of Publicly Funded Basic Research: A Critical Review," *Research Policy*, Volume 30, Issue 3, pp. 509-532.