workers for in-area workers.[23] The reason for this is that if Barton did not exist and there were fewer skilled workers in the region, businesses could still recruit and hire some of their employees from outside the Barton Service Area. With the 50% adjustment, the net labor income added to the economy thus comes to $42.9 million, as shown in Table 3.2.

But there is more. Added to the direct effect on labor income is another $22.3 million in non-labor income, representing the higher property values and increased investment income stemming from the direct income of students and enhanced productivity of the businesses that employ them. Non-labor income attributable to past student skills is obtained by disaggregating higher student income to the industrial sectors of the IO model and multiplying it by the associated value added-to-earnings ratios.[24] Summing labor and non-labor income together gives a direct effect of past student productivity equal to approximately $65.2 million in 2009-10.

Calculating the indirect effect

Economic growth stemming from a skilled workforce does not stop with the direct effect. To calculate the indirect effect, the model allocates increases in regional income to specific industrial sectors and augments these to account for both demand-side and supply-side multiplier effects. Demand-side effects refer to the increased demand for consumer goods and services as the higher incomes of skilled workers and their employers are spent in the local economy. For example, the increased output of businesses is associated with an increased demand for inputs, which in turn produces a set of regional economic multiplier effects that are all captured as part of demand-side indirect effects. In the model, these are estimated by converting higher student income into direct increased industry sales, running these through an indirect multiplier matrix, and converting them to regional income by applying earnings-to-sales and value added-to-sales ratios supplied by the regional IO model.

Supply-side effects occur through a process of "cumulative causation," or "agglomeration," whereby growth becomes in some degree self-perpetuating. The presence of one industry, for example, attracts other industries that use the first industry's outputs as inputs, which produces subsequent rounds of industry growth,

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[23] The 50% adjustment is an assumption—there is no way to determine precisely how many workers could have been recruited from outside the region if Barton did not exist. For a sensitivity analysis of the substitution variable, please see Chapter 4.

[24] There are twenty-one top-level industry sectors in the EMSI IO model. Disaggregating direct student earnings in this fashion avoids aggregation error. See chapter 5 in Ron Miller and Peter Blair, *Input-Output Analysis: Foundations and Extensions* (Englewood Cliffs, NJ: Prentice Hall, 1985).

and so on.[25] To estimate agglomeration effects, the model converts the direct income of past students to industry value added and applies this to a set of supply-driven multipliers provided by the regional IO model. To increase the plausibility of this assumption, the model applies only direct effects associated with industries in the highest stages of development.[26]

The sum of demand-side and supply-side effects constitutes the indirect effect of Barton education, equal to $7.6 million of all labor income and approximately $4 million of all non-labor income (Table 3.3). Adding these to the direct effects of student productivity yields a grand total of $76.8 million in added income attributable to the accumulation of Barton skills in the regional workforce. This figure appears in the bottom row of Table 3.3.

Table 3.3: Barton student productivity effect, 2009-10 ($ thousands)

	Labor income	Non labor income	Total	% of Total
Total income in service region	$1,441,983	$1,064,078	$2,506,060	
Direct effect	$42,877	$22,349	$65,226	2.6%
Indirect effect	$7,565	$4,007	$11,572	0.5%
Total	**$50,442**	**$26,356**	**$76,797**	**3.1%**

Source: EMSI impact model.

Note that the $76.8 million omits the effect of educated workers on innovation and technical progress. This effect is generally labeled as "external" because it is uncertain in nature and spills beyond businesses employing skilled workers. For this reason it is excluded from the analysis. To the extent there are such effects, and theory suggests that there are, the overall results can be considered conservative.

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25 For a more complete discussion of agglomeration and cumulative causation, see Masahisa Fujita, Paul Krugman, and Anthony Venables, *The Spatial Economy: Cities, Regions, and International Trade* (Cambridge: Massachusetts Institute of Technology, 1999).

26 Parr (1999) describes the following four stages of economic development: primary production, process manufacturing, fabricative manufacturing, and producer services and capital export. The model applies "development scores" to Parr's stages, *i.e.*, low scores for lower stage sectors and higher scores for higher development sectors. Only those industries with the highest scores are applied to the supply-driven multipliers of the IO model. For additional detail on the use of this approach for classifying industries by industrial stage, see Rutgers *et al*, 2002.

Conclusion

Table 3.4 displays the grand total of Barton's impact on the Barton Service Area in 2009-10, including the college operations effect and the student productivity effect. Results depend on, first, the number of Barton employees who live and work in the region, and second, the accumulation of skills (or credits) currently active in the regional workforce.

Table 3.4: Total effect of Barton, 2009-10 ($ thousands)

	Total	% of Total
Total income in service region	$2,506,060	
College operations effect	$12,490	0.5%
Student productivity effect	$76,797	3.1%
Total	**$89,288**	**3.6%**

Source: EMSI impact model.

These results demonstrate several important points. First, Barton promotes regional economic growth through its own operations spending and through the increase in productivity as former Barton students remain active in the regional workforce. Second, the student productivity effect is by far the larger and more important impact of Barton, stemming from higher incomes of students and their employers. And third, regional income in the Barton Service Area would be substantially lower without the educational activities of Barton.

Chapter 4: Sensitivity Analysis

Introduction

This study concludes with a sensitivity analysis of some key variables on both the student and taxpayer investment sides. The purpose of the sensitivity analysis is to set the approach apart from "advocacy" education impact analyses that promote education. These studies often use assumptions that do not stand up to rigorous peer scrutiny and generate results that overstate benefits. The approach here is to account for relevant variables in calculating benefits and costs as reflected in the conservatively estimated base case assumptions laid out in Chapters 2 and 3.

The sensitivity tests include the following: a) the impacts associated with changes in the student employment variables for the investment analysis, b) the sensitivity of results associated with the alternative education variable, and c) the sensitivity of results associated with the substitution variable.

Student employment variables

Student employment variables are difficult to estimate either because many students do not report their employment status or because colleges generally do not collect this kind of information. Employment variables include the following: 1) the percentage of students employed, and 2) of those employed, what percentage they earn relative to earnings they would have received if they were not attending Barton. Both employment variables relate to earnings forgone by students, *i.e.*, the opportunity cost of time; and they affect the investment analysis results (net present value, rate of return, benefit/cost ratio, and payback period).

Percent of students employed

Students incur substantial expense by attending Barton because of the time they spend not gainfully employed. Some of that cost is recaptured if students remain partially (or fully) employed while attending. It is estimated that 75% of students who reported their employment status are employed, based on data provided by Barton. This variable is tested in the sensitivity analysis by changing it first to 100% and then to 0%.

Percent of earnings relative to full earnings

The second opportunity cost variable is more difficult to estimate. For Barton, it is estimated that students working while attending classes earn only 66%, on average, of the earnings they would have statistically received if not attending Barton. This suggests that many students hold part-time jobs that accommodate their Barton attendance, though it is at an additional cost in terms of receiving a wage that is less than what they might otherwise make. The model captures these differences and counts them as part of the opportunity cost of time. As above, this variable is tested in the sensitivity analysis by changing the assumption to 100% and then to 0%.

Results

The changed assumptions generate results summarized in Table 4.1, with "A" defined as the percent of students employed and "B" defined as the percent that students earn relative to their full earning potential. Base case results appear in the shaded row – here the assumptions remain unchanged, with A equal to 75% and B equal to 66%. 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 4.1: Sensitivity analysis of Barton student perspective

Variables	Rate of Return	Benefit/Cost	Payback
Base case: A = 75%, B = 66%	15.8%	4.7	9.2
Scenario 1: A = 100%, B = 66%	17.5%	5.5	8.5
Scenario 2: A = 75%, B = 100%	20.1%	6.9	7.6
Scenario 3: A = 100%, B = 100%	26.8%	10.6	6.1
Scenario 4: A = 0%, B = 0%	12.3%	3.3	11.2

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

1. Scenario 1: Increasing the percent of students employed (A) from 75% to 100%, the rate of return, benefit/cost ratio, and payback period results improve to 17.5%, 5.5, and 8.5 years, respectively, relative to base case results. Improved results are attributable to a lower opportunity cost of time—all students are employed in this case.
2. Scenario 2: Increasing earnings relative to statistical averages (B) from 66% to 100%, the rate of return, benefit/cost ratio, and payback period results improve to 20.1%, 6.9, and 7.6 years, respectively, relative to base case results—a strong improvement, again attributable to a lower opportunity cost of time.
3. Scenario 3: Increasing both assumptions A and B to 100% simultaneously, the rate of return, benefit/cost ratio, and payback period results improve yet further to 26.8%, 10.6, and 6.1 years, respectively,

relative to base case results. This scenario assumes that all students are fully employed and earning full salaries (equal to statistical averages) while attending classes.

4. Scenario 4: Finally, decreasing both A and B to 0% reduces the rate of return, benefit/cost ratio, and payback period results to 12.3%, 3.3, and 11.2 years, respectively, relative to base case results. These results are reflective of an increased opportunity cost—none of the students are employed in this case.[27]

It is strongly emphasized in this section that base case results are very attractive in that results are all above their threshold levels, and payback periods are short. As is clearly demonstrated here, results of the first three alternative scenarios appear much more attractive, although they overstate benefits. Results presented in Chapter 2 are realistic, indicating that investments in Barton generate excellent returns, well above the long-term average percent rates of return in stock and bond markets.

Alternative education variable

The alternative education variable (22%) is characterized as a "negative benefit" used to account for students who can obtain a similar education elsewhere absent the publicly funded training providers in the state. Given the difficulty in accurately specifying the alternative education variable, the obvious question is the following: how great a role does it play in the magnitude of the results?

Variations in the alternative education assumption are calculated around base case results listed in the middle column of Table 4.2. Next, the model brackets the base case assumption on either side with a plus or minus 17%, 33%, and 50% variation in assumptions. Analyses are then redone introducing one change at a time, holding all other variables constant. For example, an increase of 17% in the alternative education assumption (from 22% to 26%) reduces the taxpayer perspective rate of return from 7.6% to 7.2%. Likewise, a decrease of 17% (from 22% to 19%) in the assumption increases the rate of return from 7.6% to 7.9%.

[27] Note that reducing the percent of students employed to 0% automatically negates the percent they earn relative to full earning potential, since none of the students receive any earnings in this case.

Table 4.2: Sensitivity analysis of alternative education variable, taxpayer perspective ($ millions)

	50%	33%	17%	Base Case	17%	33%	50%
Alternative education variable	11%	15%	19%	22%	26%	30%	33%
Net present value	$23.9	$22.2	$20.5	$18.7	$17.0	$15.3	$13.6
Rate of return	8.5%	8.2%	7.9%	7.6%	7.2%	6.9%	6.5%
Benefit/cost ratio	2.4	2.3	2.2	2.1	2.0	1.9	1.8
Payback period (years)	14.3	14.7	15.1	15.5	16.0	16.4	17.0

Based on this sensitivity analysis, the conclusion can be drawn that Barton investment analysis results from the taxpayer perspective are not very sensitive to relatively large variations in the alternative education variable. As indicated, results are still above their threshold levels (net present value greater than 0, benefit/cost ratio greater than 1, and rate of return greater than the discount rate of 3%) even when the alternative education assumption is increased by as much as 50% (from 22% to 33%). The conclusion is that although the assumption is difficult to specify, its impact on overall investment analysis results for the taxpayer perspective is not very sensitive.

Substitution variable

The substitution variable only affects the student productivity calculation in Table 3.5. In the model we assume a substitution variable of 50%, which means that we claim only 50% of the direct labor income generated by increased worker productivity. The other 50% we assume would have occurred even if Barton did not exist. This is because, if there were no Barton students to hire, some businesses could have recruited similarly qualified individuals from outside the region.

Table 4.3 presents the results of the sensitivity analysis for the substitution variable. As above, the assumption increases and decreases relative to the base case of 50% by the increments indicated in the table. Impacts on the results are more pronounced. Student productivity effects attributable to Barton, for example, range from a high of $115.2 million at 50% to a low of $38.4 million at a -50% variation from the base case assumption for this variable. This means that if the substitution variable were to decrease, the number of benefits that we claim also decreases; hence, the income attributable to Barton decreases accordingly.

Table 4.3: Sensitivity analysis of substitution variable on student productivity ($ millions)

	50%	33%	17%	Base Case	17%	33%	50%
Substitution variable	25%	33%	42%	50%	58%	67%	75%
Student productivity effect	$38.4	$51.2	$64.0	$76.8	$89.6	$102.4	$115.2
Total effect	$50.9	$63.7	$76.5	$89.3	$102.1	$114.9	$127.7
Percent of regional income	2.0%	2.5%	3.1%	3.6%	4.1%	4.6%	5.1%

It is important to note that, even under the most conservative assumptions, the total effect of Barton — including the effects of college operations and student productivity — still remains a sizeable factor in the Barton Service Area economy. The college operations effect is kept constant for this sensitivity analysis, so the variations in the total effect are caused solely by the changes to student productivity in the second row. The last row of the table shows the percent of total regional income that is attributable to Barton and its students.

Conclusion

The results of this study demonstrate that Barton is a sound investment from multiple perspectives. The college enriches the lives of students and increases their lifetime incomes. It benefits taxpayers by generating increased tax revenues from an enlarged economy and reducing the demand for taxpayer-supported social services. Finally, it contributes to the vitality of both the local and state economies.

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Appendix 3: EMSI Input-Output Model

Introduction and data sources

EMSI's input-output model represents the economic relationships among a region's industries, with particular reference to how much each industry purchases from each other industry. Using a complex, automated process, we can create regionalized models for geographic areas comprised by counties or ZIP codes in the United States.

Our primary data sources are the following:

1. The Industry Economic Accounts from the Bureau of Economic Analysis (BEA); specifically the "make" and "use" tables from the annual and benchmark input-output accounts.
2. Regional and national jobs-by-industry totals, and national sales-to-jobs ratios (from EMSI's industry employment and earnings data process).
3. Proprietor earnings from State and Local Personal Income Reports (BEA).

Creation of the national Z matrix

The BEA "make" and "use" tables (MUTs) show which industries make or use which commodity types. These two tables are combined to replace the industry-commodity-industry relationships with simple industry-industry relationships in dollar terms. This is called the national "Z" matrix, which shows the total amount ($) each industry purchases from others. Industry purchases run down the columns, while industry sales run across the rows.

Table 1: Sample "Z" matrix ($ millions)

	Industry 1	Industry 2	. . .	Industry N
Industry 1	3.3	1,532.5	. . .	232.1
Industry 2	9.2	23.0	. . .	1,982.7
. . .	. . .	. . .	. . .	. . .
Industry N	819.3	2,395.6	. . .	0

The value 1,532.5 in this table means that Industry 2 purchases $1,532,500,000 worth of commodities and/or services from Industry 1.

The whole table is basically an economic double-entry accounting system, configured so that all money inflows have corresponding outflows elsewhere.

In addition to regular industries (such as "oil and gas extraction," "machinery manufacturing," "food and beverage stores," "hospitals," and so on), there are three additional rows representing labor earnings, profits, and business taxes, which together represent industry "value added" and account for the fact that industries do not spend all of their income on inputs from other industries. There are also three rows and columns representing federal, state, and local government (we later separate federal government into civilian and military sectors).

We create two separate Z matrices since there are two sets of MUTs—annual and benchmark. The benchmark data are produced every five years with a five-year lag and specify up to 500 industry sectors; annual data have a one-year lag but specify only 80 industrial sectors.

The basic equation is as follows:

Z = VQˆ-1U

where V is the industry "make" table, Qˆ-1 is a vector of total gross commodity output, and U is the industry "use" table.

In reality, this equation is more complex because we also need to "domesticate" the Z matrix by removing all imports. This is needed because we are creating a "closed" type of national model.

In addition, there are a number of modifications that need to be made to the BEA data before the calculations can begin. These are almost all related to the conversion of certain data in BEA categories to new categories that are more compatible with other data sets we use in the process, and describing them in detail is beyond the scope of this document.

Disaggregation of the national Z matrix

The previous step resulted in two national Z matrices—one based on the benchmark BEA data (five years old, approximately 500 industries) and the other based on the annual BEA data (one year old, but only about 80 industries). These initial national Z matrices are then combined and disaggregated to 1,125 industry sectors. Combining them allows us to capitalize on both the recency of the annual data and the detail of the benchmark data. The disaggregation is performed for each initial Z matrix using probability matrices that allow us to estimate industry transactions for the more detailed sectors based on the known transactions of their parent sectors. The probability matrix is created from detailed EMSI industry earnings data, which are available for all 1,125 sectors and are created using a separate process.

Creation of the national A matrix

The national disaggregated Z matrix is then "normalized" to show purchases as percentages of each industry's output rather than total dollar amounts. This is called the national "A" matrix.

Table 2: Sample "A" matrix

	Industry 1	Industry 2	. . .	Industry 1125
Industry 1	.001	.112	. . .	.035
Industry 2	.097	0	. . .	.065
. . .	. . .	. . .	. . .	. . .
Industry 1125	.002	.076	. . .	0

Each cell value represents the percentage of a row industry's output that goes toward purchasing inputs from each column industry. Thus, the cell containing .112 above means that Industry 1 spends 11.2% of its total output to obtain inputs from Industry 2.

At this point, our additional rows representing earnings, profits, and business taxes are removed. However, we will use them in a different form later.

Regionalization of the A matrix

To create a regional input-output model, we regionalize the national A matrix using that region's industry mix.

The major step in the process is the calculation of per-industry out-of-region exports. This is performed using a combination of the following standard techniques that are present in the academic literature:

1. Stevens regional purchase coefficients (RPCs)
2. Simple location quotient of value added sales
3. Supply/demand pools derived from the national A matrix

We try to maximize exports in order to account as fully as possible for "cross-hauling," which is the simultaneous export and import of the same good or service to/from a region, since it is quite common in most industries.

Another major part of the process is the regionalization of consumption, investment, and local government "row industries" (rows referring to the rows of the A matrix). These represent the percentage of each industry's sales that end up going toward consumption, capital purchases, and taxes to local government, respectively. They are created from the "value added" rows that we removed earlier. Consumption is calculated using each industry's earnings and profits, as well as a constant called "the average propensity to consume," which describes the approximate percentage of earnings and profits that are spent on consumption. Investment and local government rows are calculated by distributing the known total investment and endogenous local government for the entire region to individual industries proportionally to their value added.

The A-matrix regionalization process is automated for any given region for which industry data are available. Although partially derived from national figures, the regional A matrix offers a best possible estimate of regional values without resorting to costly and time-consuming survey techniques, which in most cases are completely infeasible.

Creating multipliers and using the A matrix

Finally, we convert the regional "A" matrix to a "B" matrix using the standard Leontief inverse $B = (I - A) - 1$. The "B" matrix consists of inter-industry sales multipliers, which can be converted to jobs or earnings multipliers using per-industry jobs-to-sales or earnings-to-sales ratios.

The resulting tables and vectors from this process are then used in the actual end-user software to calculate regional requirements, calculate the regional economic base, estimate sales multipliers, and run impact scenarios.

Appendix 4: Shutdown Point

Introduction

The investment analysis weighs benefits of enrollment (measured in terms of CHEs) against the support provided by state and local governments. This adjustment factor is used to establish a direct link between the costs of supporting the college and the benefits it generates in return. If benefits accrued without taxpayer support, then it would not be a true investment.[28]

The overall approach includes a sub-model that simulates the effect on student enrollment should the college lose its state and local funding and have to raise student tuition and fees in order to stay open. If the college 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 college cannot stay open, however, then benefits are directly linked to costs, and no discounting applies. This appendix documents the procedure for making these adjustments.

State and local government support versus student demand

Figure 1 presents a simple model of student demand and state 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 CHEs generated and expressed as a percentage of current CHE production. Current student tuition and fees are represented by p', and state and local government support covers C% of all costs. At this point in the analysis, it is assumed that the college has only two sources of revenues: (1) student tuition and fees, and; (2) state and local government support.

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[28] Of course, as a public training provider, Barton 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 Barton 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.

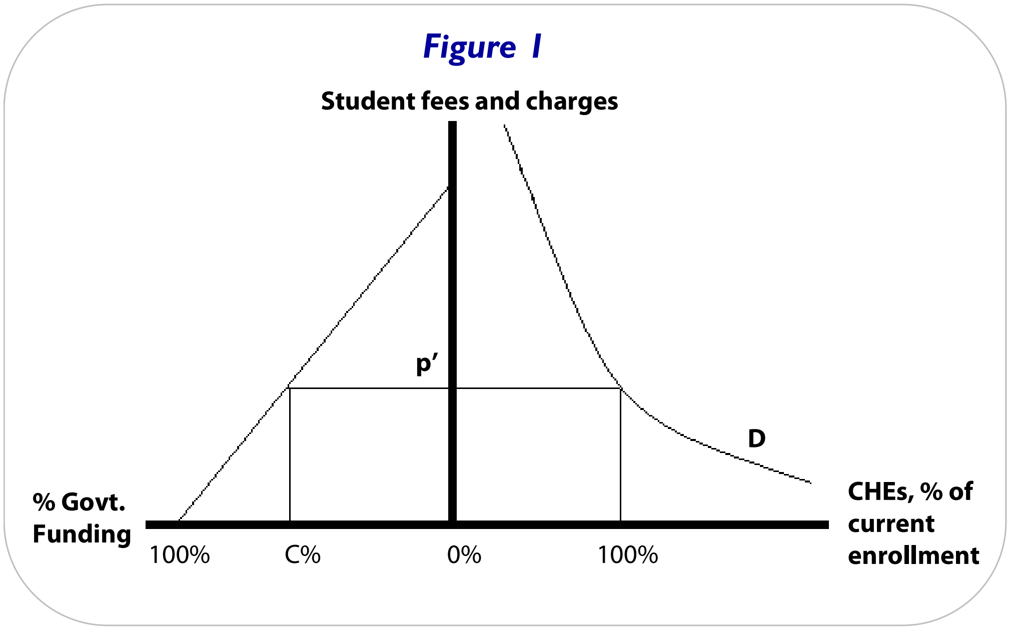
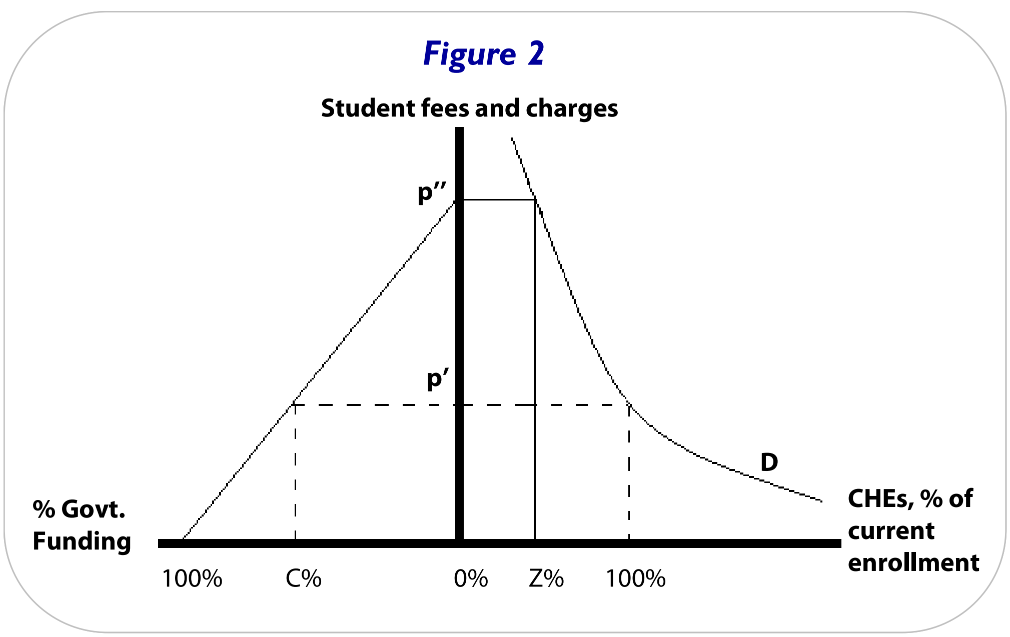


Figure 2 shows another important reference point in the model—where state and local government support is 0%, student tuition and fees are increased to p", and enrollment is Z% (less than 100%). The reduction in enrollment reflects price elasticity in the students' education vs. no-education decision. Neglecting for the moment those issues concerning the college's minimum operating scale (considered below in the section called "Shutdown Point"), the implication for the investment analysis is that benefits of state and local government support must be adjusted to net out benefits associated with a level of enrollment at Z% (*i.e.*, the college can provide these benefits absent state and local government support).



From enrollment to benefits

This appendix focuses mainly on the size of enrollment (*i.e.*, CHE production) and its relationship to student versus state and local government funding. However, to clarify the argument it is useful to briefly consider the role of enrollment in the larger benefit/cost model.

Let B equal the benefits attributable to state and local government support. The analysis derives all benefits as a function of student enrollment (*i.e.*, CHE production). For consistency with the graphical exposition elsewhere in this appendix, B is expressed as a function of the percent of current enrollment (*i.e.*, percent of current CHE production). Accordingly, the equation

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

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

Consider benefits now with reference to Figure 2. The point at which state 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) $B = B\ (Z\%)$

Inasmuch as the benefits in (2) occur with or without state and local government support, the benefits appropriately attributed to state and local government support are given by the following equation:

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

Shutdown point

College operations cease when fixed costs can no longer be covered. The shutdown point is introduced graphically in Figure 3 as S%. The location of point S% indicates that the college can operate at an even lower enrollment level than Z% (the point of zero state funding). At point S%, state and local government support is still zero, and student tuition and fees have been raised to p'''. With student tuition and fees still higher than p''', the college would not be able to attract enough students to keep the doors open, and it would shut down. In Figure 3, point S% illustrates the shutdown point but otherwise plays no role in the estimation of taxpayer benefits. These remain as shown in equation (3).

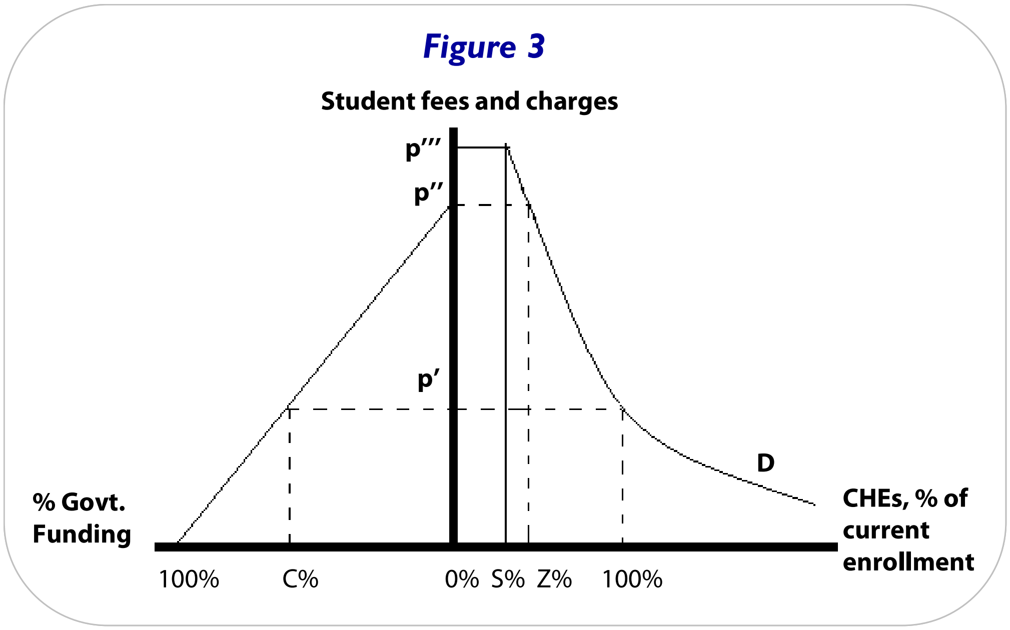
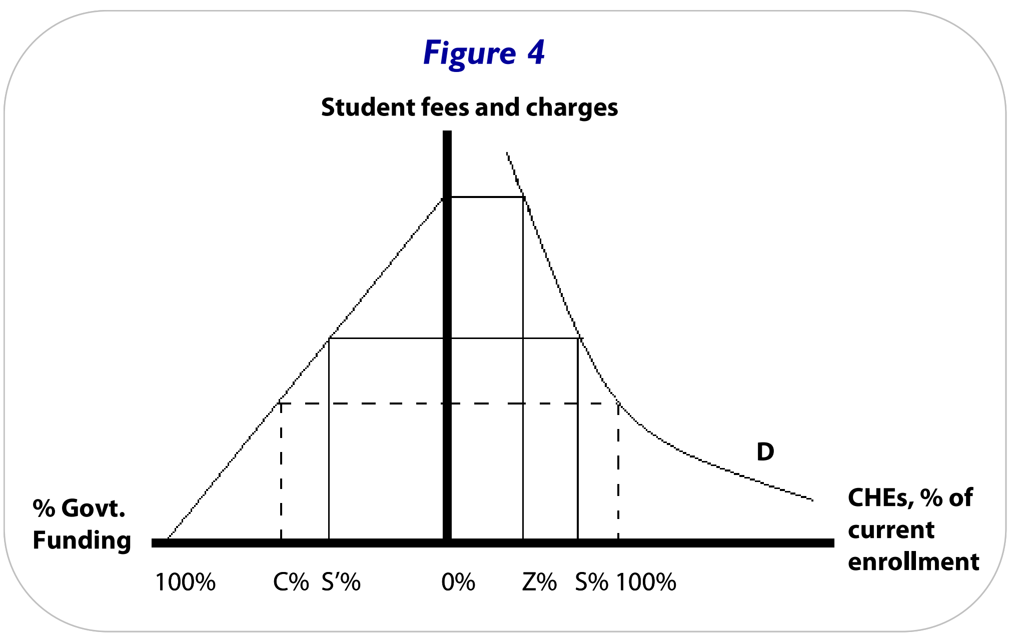


Figure 4 illustrates yet another scenario. Here the shutdown point occurs at an enrollment level greater than Z% (the level of zero state and local government support), meaning some minimum level of state and local government support is needed for the college to operate at all. This minimum portion of 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, state and local government support is appropriately credited with all the benefits generated by enrollment, or B = B (100%).



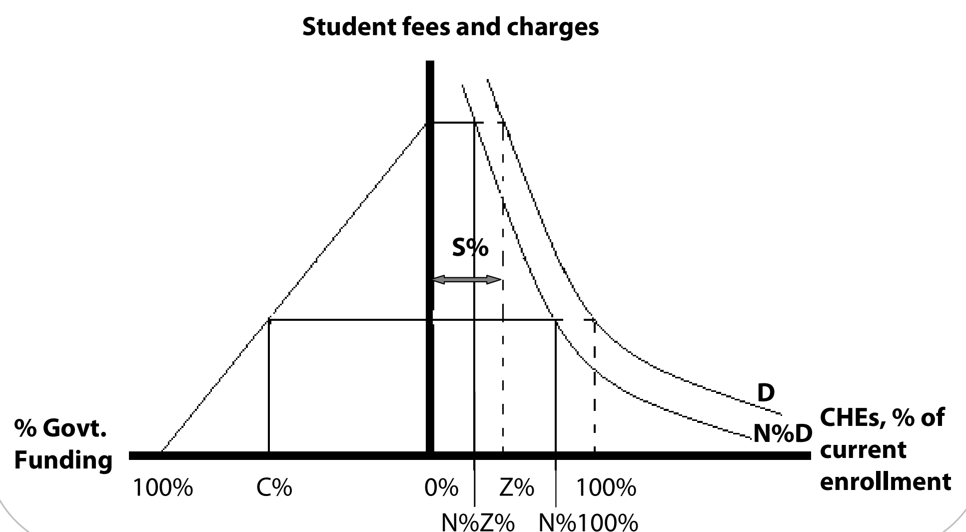
Adjusting for alternative education opportunities

Because some students may be able to avail themselves of an education even without the publicly funded training providers in the state, the benefits associated with these students must be deducted from the overall benefit estimates. The adjustment for alternative education is easily incorporated into the simple graphic model. For simplicity, let A% equal the percent of students with alternative education opportunities, and let N% equal the percent of students without an alternative. Note that N% + A% = 100%.

Figure 5 presents the case where the college could operate absent state and local government support (*i.e.*, Z% occurs at an enrollment level greater than the shutdown level S%). In this case, the benefits generated by enrollments absent state and local government support must be subtracted from total benefits. This case is parallel to that indicated in equation (3), and the net benefits attributable to state and local government support are given by the following equation:

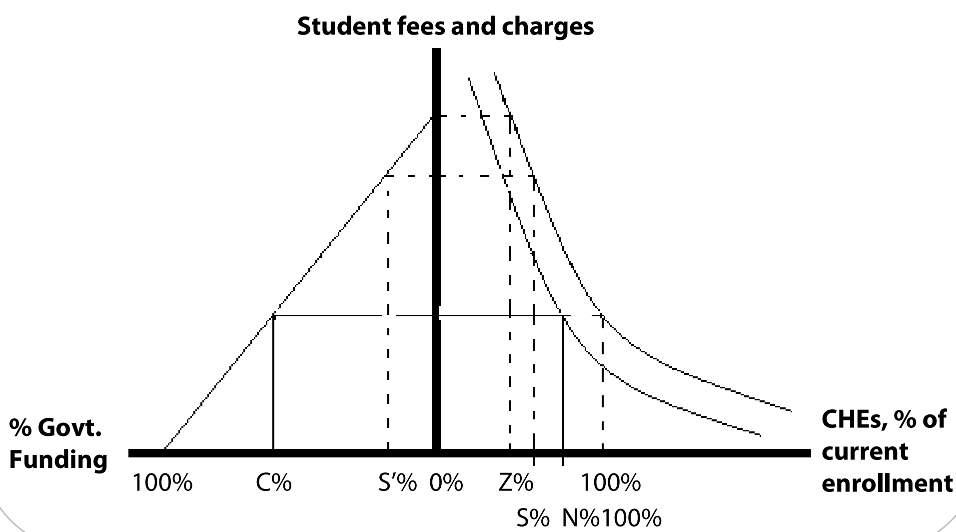
4) $B = B\ (N\% \times 100\%) - B\ (N\% \times Z\%)$

Figure 5



Finally, Figure 6 presents the case where the college cannot remain open absent some minimum S'% level of state and local government support. In this case, taxpayers are credited with all benefits generated by current enrollment, less only the percent of students with alternative education opportunities. These benefits are represented symbolically as B (N% × 100%).

Figure 6



Appendix 5: Social Externalities

Introduction

Education has a predictable and positive effect on a diverse array of social benefits. These, when quantified in dollar terms, represent significant avoided social costs that directly benefit the public as whole, including taxpayers. In this appendix we discuss the following three main benefit categories: 1) improved health, 2) reductions in crime, and 3) reductions in unemployment and welfare.

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

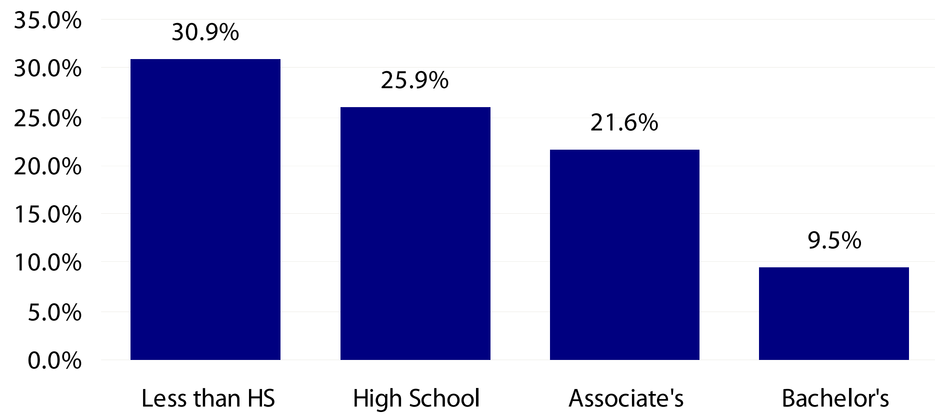
Statistics clearly show the correlation between increases in education and improved health. The manifestations of this are found in two health-related variables, smoking and alcohol. There are probably several other health-related areas that link to educational attainment, but these are omitted from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

Smoking

Despite declines over the last several decades in the percentage of the U.S. population who smoke, a sizeable percentage of the U.S. population still use tobacco. The negative health effects of smoking are well documented in the literature, which identifies smoking as one of the most serious health issues in the United States.

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

Figure 1: Prevalence of smoking by education level



The CDC reports the percent of adults who are current smokers by state.[29] We use this information to create an index value by which we adjust the national prevalence data on smoking to each state. For example, 20.1% of Ohio's adults were smokers in 2008, relative to 18.3% for the nation. We thus apply a scalar of 1.1 to the national probabilities of smoking in order to adjust them to the state of Ohio.

Alcohol

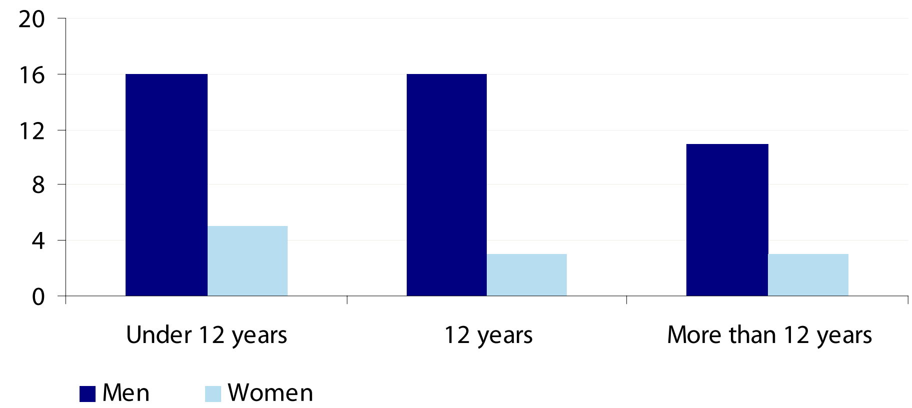
Alcoholism is difficult to measure and define. There are many patterns of drinking, ranging from abstinence to heavy drinking. Alcohol abuse is riddled with social costs, including health care expenditures for treatment, prevention and support; workplace losses due to reduced worker productivity and premature mortality; and other costs related to vehicle crashes, fire destruction, and social welfare administration.

Figure 2 presents the percent of the adult population that are heavy drinkers, by gender and education level.[30] These statistics give an indication of the correlation between education and the reduced probability of alcohol abuse. As indicated, heaving drinking among males falls from a 16% prevalence rate among individuals with fewer than 12 years of education, to an 11% prevalence rate among individuals with more than 12 years of education. The probability of being a heavy drinker also falls on a sliding scale for women, from 5% to 3%. Note that women are less likely to be heavy drinkers than men.

[29] Center for Disease Control and Prevention (CDC), Prevalence and Trends Data, Tobacco Use - 2008, Adults who are current smokers (accessed June 2009).

[30] Data are supplied by the National Institute of Alcohol Abuse and Alcoholism.

Figure 2: Prevalence of heavy drinking by gender and education level

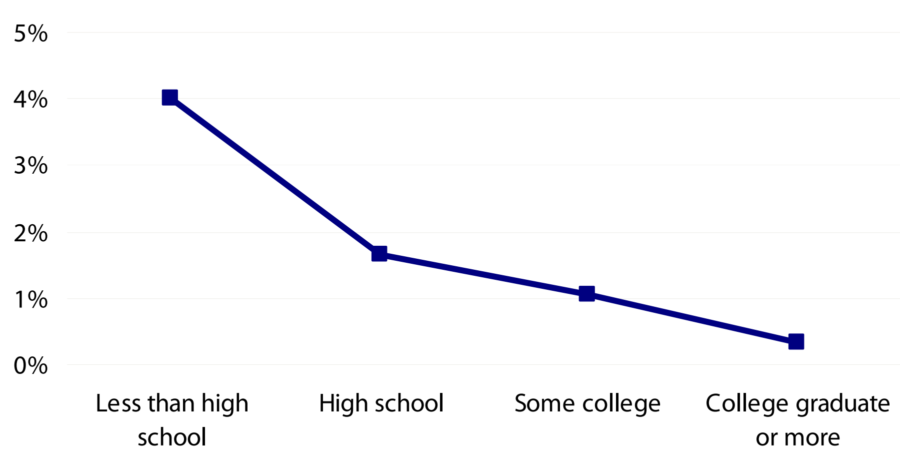


Crime

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) incarceration, including prosecution, imprisonment, and reform, 2) victim costs, and 3) productivity lost as a result of time spent in jail or prison rather than working.

Figure 3 displays the probability that an individual will be incarcerated by education level. Data are derived from the breakdown of the inmate population by education level in state, federal, and local prisons (as provided by the Bureau of Justice Statistics), divided by the total population. As indicated, incarceration drops on a sliding scale as education levels rise.

Figure 3: Incarceration rates by education level



Victim costs comprise material, medical, physical, and emotional losses suffered by crime victims. Some of these costs are hidden, while others are available in various databases. Estimates of victim costs vary widely, attributable to differences in how the costs are measured. The lower end of the scale includes only tangible out-of-pocket costs, while the higher end includes intangible costs such as future loss of productivity resulting from traumas, crimes not handled or prosecuted through the judicial system, and money spent on personal security that would otherwise have been spent on other, more productive endeavors.[31]

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

Welfare and Unemployment

Statistics show that as education levels increase, the number of welfare and unemployment applicants declines. Welfare recipients can receive assistance from a variety of different sources, including TANF (Temporary Assistance for Needy Families), food stamps, Medicaid, Supplemental Security Income (SSI), housing subsidies, child care services, weatherization programs, and various educational programs.

Figure 4 relates the probabilities that an individual will apply for welfare by education level, derived from data supplied by the Department of Health and Human Services. As shown, the probability of claiming welfare drops significantly as individuals move to higher levels of education. Note that these data are based on TANF recipients only, as these constitute the most needy welfare recipients and are the point of departure for the allocation between the other ethnic groups in the model.

Unemployment rates also decline with increasing levels of education, as illustrated in Figure 5. These data are supplied by the Bureau of Labor Statistics. As shown, unemployment rates range from 9% for those with less than a high school diploma to 2% for those at the doctoral degree level.

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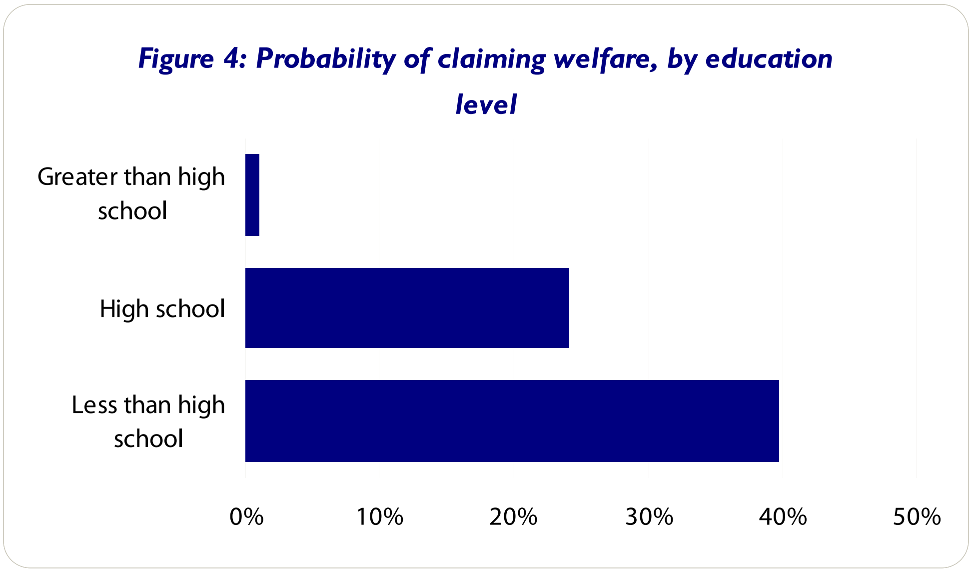
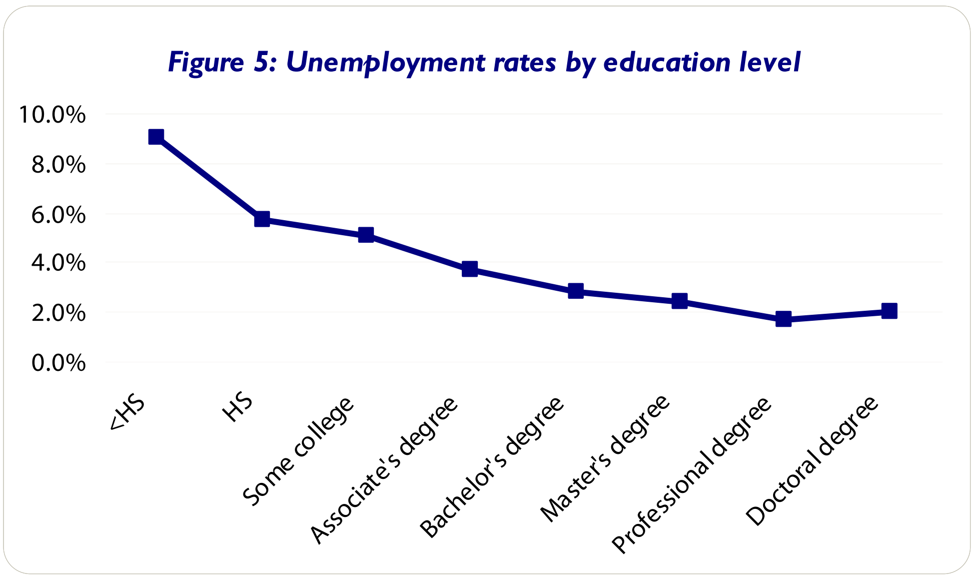
[31] The model makes use of tangible, lower end costs that can be directly measured without controversy. Thus, 2.0 million inmates (in 1999) divided into $105 billion costs an average of roughly $52,000 per inmate. From this we derive an estimate of $85,000, assuming that the 1999 study was based on at least two- to three-year-old data.





Conclusion

The statistical databases bear out the simple correlation between education and improved health, lower incarceration rates, and reduced welfare and unemployment. These by no means comprise the full range of benefits one possibly can link to education. Other social benefits certainly may be identified in the future as reliable statistical sources are published and data are incorporated into the analytical framework. However, the fact that these incidental benefits occur and can be measured is a bonus that enhances the economic attractiveness of college operations.

Appendix 6: Investment Analysis – a Primer

The purpose of this appendix is to provide some context and meaning to the investment analysis results in general, using the simple hypothetical example summarized in Table 1 below. The table shows the projected (assumed) benefits and costs over time for one student and associated investment analysis results.[32]

Table 1. Costs and benefits

Year	Tuition	Opportunity cost	Total cost	Higher earnings	Net cash flow
1	2	3	4	5	6
1	$1,500	$20,000	$21,500	$0	-$21,500
2	$0	$0	$0	$5,000	$5,000
3	$0	$0	$0	$5,000	$5,000
4	$0	$0	$0	$5,000	$5,000
5	$0	$0	$0	$5,000	$5,000
6	$0	$0	$0	$5,000	$5,000
7	$0	$0	$0	$5,000	$5,000
8	$0	$0	$0	$5,000	$5,000
9	$0	$0	$0	$5,000	$5,000
10	$0	$0	$0	$5,000	$5,000
Net present value			**$20,680**	**$35,753**	**$15,080**
Internal rate of return					**18%**
Benefit/cost ratio					**1.7**
Payback period					**4.2 years**

Assumptions are as follows:

1. The time horizon is 10 years—*i.e.*, benefits and costs are projected out 10 years into the future (Column 1). Once education has been earned, benefits of higher earnings remain with the student into the future. The objective is to measure these future benefits and compare them to the costs of education.

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

2. The student attends the college for one year, for which he or she pays total fees of $1,500 (Column 2).
3. The opportunity cost of time (earnings forgone while attending the college for one year) for this student is estimated at $20,000 (Column 3).
4. Together, these two cost elements ($21,500 total) represent the out-of-pocket investment made by the student (Column 4).
5. In return, it is assumed that the student, having completed the one year of study, will earn $5,000 more per year than he/she would have without the education (Column 5).
6. Finally, the net cash flow column (NCF) in Column 6 shows higher earnings (Column 5) less the total cost (Column 4).
7. 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 (NPV), the internal rate of return (IRR, or simply RR), the benefit/cost ratio (B/C), and the payback period. Each of these is briefly explained below in the context of the cash flow numbers in Table 1.

Net present value (NPV)

"A bird in hand is worth two in the bush." This simple folk wisdom lies at the heart of any economic analysis of investments lasting more than one year. The student in Table 1 can choose either to attend the college or to forgo post-secondary education and maintain present employment. If he or she decides to enroll, certain economic implications unfold: student tuition and fees must be paid, and earnings will cease for one year. In exchange, the student calculates that with post-secondary education, his or her income will increase by at least the $5,000 per year as indicated in the table.

The question is simple—will the prospective student be economically better off by choosing to enroll? If he/she adds up higher earnings of $5,000 per year for the remaining nine years in Table 1, the total will be $45,000. Compared to a total investment of $21,500, this appears to be a very solid investment. The reality, however, is different—benefits are far lower than $45,000 because future money is worth less than present money. Costs (student tuition and fees plus forgone earnings) are felt immediately because they are incurred today—in the present. Benefits (higher earnings), 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.[33] 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 ten, 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 ten years. An "economically rational" person would, therefore, be equally satisfied receiving $3,377 today or $5,000 ten years from today given the going rate of interest of 4%. The process of discounting—finding the present value of future higher earnings—allows the model to express values on an equal basis in future or present value terms.

The goal is to express all future higher earnings in present value terms so that they can be compared to investments incurred today—student tuition and fees and forgone earnings. As indicated in Table 1, the cumulative present value of $5,000 worth of higher earnings between years 2 and 10 is $35,747 given the 4% interest rate, far lower than the undiscounted $45,000 discussed above.

The net present value of the investment is $14,247. This is simply the present value of the benefits less the present value of the costs, or $35,747 − $21,500 = $14,247. In other words, the present value of benefits exceeds the present value of costs by as much as $14,247. 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 (IRR)

The internal rate of return is another way of measuring the worth of investing in education using the same cash flows shown in Table 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 NPV example above, the model applies the "going rate" of interest of 4% and computes a positive net present value of $14,247. 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 1. Or, if a discount rate of 18.0% were applied to the NPV calculations instead of the 4%, then the net present value would reduce to zero.

[33] 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.

What does this mean? The internal rate of return of 18.0% defines a breakeven solution—the point where the present value of benefits just equals the present value of costs, or where the net present value equals zero. Or, at 18.0%, higher incomes of $5,000 per year for the next nine years will earn back all investments of $21,500 made plus pay 18.0% for the use of that money ($21,500) in the meantime. Is this a good return? Indeed it is. If it is compared to the 4% "going rate" of interest applied to the net present value calculations, 18.0% is far higher than 4%. It may be concluded, therefore, that the investment in this case is solid. Alternatively, comparing the 18.0% rate of return to the long-term 7% rate or so obtained from investments in stocks and bonds also indicates that the investment in education is strong relative to the stock market returns (on average).

A word of caution—the IRR approach can sometimes generate "wild" or "unbelievable" results—percentages that defy the imagination. Technically, the approach requires at least one negative cash flow (student tuition and fees plus opportunity cost of time) to offset all subsequent positive flows. For example, if the student works full-time while attending the college, the opportunity cost of time would be much lower; the only out-of-pocket cost would be the $1,500 paid for student tuition and fees. In this case, it is still possible to compute the internal rate of return, but it would be a staggering 333% because only a negative $1,500 cash flow will be offsetting nine subsequent years of $5,000 worth of higher earnings. The 333% return is technically correct, but not consistent with conventional understanding of returns expressed as percentages. For purposes of this report, therefore, all results exceeding 100% are expressed simply as: "n/a" or ">100%."

Benefit/cost ratio (B/C)

The benefit/cost ratio is simply the present value of benefits divided by present value of costs, or $35,747 ÷ $21,500 = 1.7 (based on the 4% discount rate). Of course, any change in the discount rate will 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—or 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 student tuition and fees plus earnings forgone) until higher future earnings give a return on the investments made. For the student in Table 1, it will take roughly 4.2 years of $5,000 worth of higher earnings to recapture his or her investment of $1,500 in student tuition and fees and the $20,000 earnings he or she forgoes while attending the college. Higher earnings occurring beyond 4.2 years are the returns that make the investment in education in this example economically worthwhile. The payback period is a fairly rough, albeit common, means of choosing between investments. The shorter the payback period, the stronger the investment.

Appendix 7: Alternative Education Variable

Introduction

The alternative education variable is the percent of students who would still be able to avail themselves of education absent the publicly funded colleges and universities in the state. This variable is estimated in the model through a regression analysis based on data supplied by 117 colleges previously analyzed by EMSI. The purpose of this appendix is to lay out the theoretical framework for determining the alternative education opportunity variable and the data used to make this determination.

Alternative education variable in function form

The alternative education variable is the dependent variable, expressed in functional form as follows:

1) $Y = b_1X_1 + b_2X_2 + b_3X_3 + e$

Where:

Y = Dependent variable

b_i = partial regression coefficients

e = standard error

Independent variables

The three independent variables reflect the explanatory parameters that form the theoretical backdrop to the internal estimation of the dependent variable based on 117 observations. The three independent variables include the following:

X_1 = Population per square mile in the service region

This variable defines the population density of the service region. A positive coefficient (b) is expected; *i.e.*, the more densely populated the area, the more numerous the alternative education opportunities will be.[34]

X_2 = Number of private school employees per 1,000 population per square mile in the service region

This variable is a proxy for the availability of private educational institutions providing alternative education opportunities in the region. A positive coefficient (b)

[34] Available from U.S. Census Bureau, Current Population Survey.

is expected; *i.e.,* the more private school employees, the more alternative education opportunities there are in the area.[35]

X_3 = Personal income

The average personal income of residents in the region serves as a measure of the relative economic well-being of the area. A positive coefficient (b) is expected; *i.e.,* the higher the average earnings in the area, the more the students will be able to avail themselves of the alternative education opportunities. This number is expressed in thousands.[36]

Example of analysis and results

The procedure used to estimate the parameters was the ordinary least squares procedure (OLS). Fitting the equation by OLS yielded the following results:

2) $Y = 3.43E - 05X_1 + 0.023565X_2 + 0.005748X_3 + 0.064722$

(2.723) (1.4765) (3.1326)

$R^2 = .458$ (coefficient of determination)

$F = 31.84$ (Fischer test statistic)

The numbers in parentheses below the coefficients are the "t" values (all statistically significant). The R^2 measures the degree to which the independent variables explain the variation in the dependent variable. The maximum R^2 attainable (1.00) is the case in which all observations fall on the regression line and all variability is explained. The .458 R^2 obtained in equation (2) indicates that nearly 46 percent of the variation in the alternative education opportunity is explained by the variables. The F-ratio indicates that the equation can be considered a good predictor of the alternative education opportunity.

The positive signs of the regression coefficients agree with expected relationships. As population density, the number of private school employees, and personal income increase, so does the provision of alternative education opportunities.

For example, suppose the college has a service region of five counties. The total population of the five counties is 188,341, while the size of the region is 3754 square miles; the average population per square mile is therefore a little over 50. Within this region, there is one higher education private school employee for every 3,000 residents. Finally, the average income per person within the region is $21,869 per year. Using these data, the following results are produced:

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[35] Available from U.S. Department of Commerce, County Business Patterns.

[36] Available from U.S. Department of Commerce, Bureau of Economic Analysis, REIS Employment and Earnings Reports.

3) $Y = (3.43E - 05 \times 50.2) + (0.023565 \times .3318) + (0.005748 \times 21.869)$

4) $Y = 13.5\%$

Thus, according to these calculations, an estimated 13.5% of the student population would have been able to receive an education elsewhere if there were no publicly funded colleges and universities in the state.