CHAPTER 4:

Sensitivity Analysis

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

ALTERNATIVE EDUCATION VARIABLE

The alternative education variable (15%) accounts for the counterfactual scenario where students would have to seek a similar education elsewhere absent the publicly-funded college in the region. Given the difficulty in accurately specifying the alternative education variable, we test the sensitivity of the taxpayer and social investment analysis results to its magnitude. Variations in the alternative education assumption are calculated around base case results listed in the middle column of Table 4.1. Next, the model brackets the base case assumption on either side with a plus or minus 10%, 25%, and 50% variation in assumptions. Analyses are then redone introducing one change at a time, holding all other variables constant. For example, an increase of 10% in the alternative education assumption (from 15% to 17%) reduces the taxpayer perspective rate of return from 8.9% to 8.7%. Likewise, a decrease of 10% (from 15% to 14%) in the assumption increases the rate of return from 8.9% to 9.0%.

Based on this sensitivity analysis, the conclusion can be drawn that MCC investment analysis results from the taxpayer and social perspectives are not very sensitive to relatively large variations in the alternative education vari-

TABLE 4.1: Sensitivity analysis of alternative education variable, taxpayer and social perspective

% VARIATION IN ASSUMPTION	-50%	-25%	-10%	BASE CASE	10%	25%	50%
Alternative education variable	8%	11%	14%	**15%**	17%	19%	23%
TAXPAYER PERSPECTIVE							
Net present value (millions)	$238	$225	$217	**$212**	$206	$199	$186
Rate of return	9.7%	9.3%	9.0%	**8.9%**	8.7%	8.4%	8.0%
Benefit-cost ratio	3.8	3.7	3.6	**3.5**	3.5	3.4	3.2
SOCIAL PERSPECTIVE							
Net present value (millions)	$3,415	$3,265	$3,175	**$3,115**	$3,055	$2,965	$2,815
Benefit-cost ratio	13.0	12.5	12.2	**11.9**	11.7	11.4	10.9

able. 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 0.7%), even when the alternative education assumption is increased by as much as 50% (from 15% to 23%). The conclusion is that although the assumption is difficult to specify, its impact on overall investment analysis results for the taxpayer and social perspective is not very sensitive.

LABOR IMPORT EFFECT VARIABLE

The labor import effect variable only affects the alumni impact calculation in Table 2.7. In the model we assume a labor import effect variable of 50%, which means that 50% of the region's labor demands would have been satisfied without the presence of MCC. In other words, businesses that hired MCC students could have substituted some of these workers with equally-qualified people from outside the region had there been no MCC students to hire. Therefore, we attribute only the remaining 50% of the initial labor income generated by increased alumni productivity to the college.

Table 4.2 presents the results of the sensitivity analysis for the labor import effect variable. As explained earlier, the assumption increases and decreases relative to the base case of 50% by the increments indicated in the table. Alumni productivity impacts attributable to MCC, for example, range from a high of $1.6 billion at a -50% variation to a low of $534.3 million at a +50% variation from the base case assumption. This means that if the labor import effect variable increases, the impact that we claim as attributable to alumni decreases. Even under the most conservative assumptions, the alumni impact on the MCC Four County Service Area economy still remains sizeable.

STUDENT EMPLOYMENT VARIABLES

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

Students incur substantial expense by attending MCC 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 84% of students who reported their employment status are employed, based on data provided by MCC. This variable is tested in the sensitivity analysis by changing it first to 100% and then to 0%.

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

TABLE 4.2: Sensitivity analysis of labor import effect variable

% VARIATION IN ASSUMPTION	-50%	-25%	-10%	BASE CASE	10%	25%	50%
Labor import effect variable	25%	38%	45%	**50%**	55%	63%	75%
Alumni impact (millions)	$1,603	$1,336	$1,175	**$1,069**	$962	$801	$534

The changes generate results summarized in Table 4.3, with A defined as the percent of students employed and B defined as the percent that students earn relative to their full earning potential. Base case results appear in the shaded row; here the assumptions remain unchanged, with A equal to 84% and B equal to 58%. Sensitivity analysis results are shown in non-shaded rows. Scenario 1 increases A to 100% while holding B constant, Scenario 2 increases B to 100% while holding A constant, Scenario 3 increases both A and B to 100%, and Scenario 4 decreases both A and B to 0%.

- **Scenario 1:** Increasing the percentage of students employed (A) from 84% to 100%, the net present value, internal rate of return, and benefit-cost ratio improve to $434 million, 14.8%, and 4.3, respectively, relative to base case results. Improved results are attributable to a lower opportunity cost of time; all students are employed in this case.
- **Scenario 2:** Increasing earnings relative to statistical averages (B) from 58% to 100%, the net present value, internal rate of return, and benefit-cost ratio results improve to $497.1 million, 22.3%, and 8.2, respectively, relative to base case results; a strong improvement, again attributable to a lower opportunity cost of time.
- **Scenario 3:** Increasing both assumptions A and B to 100% simultaneously, the net present value, internal rate of return, and benefit-cost ratio improve yet further to $531.6 million, 33.7%, and 16.2, respectively, relative to base case results. This scenario assumes that all students are fully employed and earning full salaries (equal to statistical averages) while attending classes.
- **Scenario 4:** Finally, decreasing both A and B to 0% reduces the net present value, internal rate of return, and benefit-cost ratio to $316.5 million, 9.4%, and 2.3, respectively, relative to base case results. These results are reflective of an increased opportunity cost; none of the students are employed in this case.[40]

It is strongly emphasized in this section that base case results are very attractive in that results are all above their threshold levels. As is clearly demonstrated here, results of the first three alternative scenarios appear much more attractive, although they overstate benefits. Results presented in Chapter 3 are realistic, indicating that investments in MCC generate excellent returns, well above the long-term average percent rates of return in stock and bond markets.

DISCOUNT RATE

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

40 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 4.3: Sensitivity analysis of student employment variables

% VARIATION IN ASSUMPTION	NET PRESENT VALUE (MILLIONS)	INTERNAL RATE OF RETURN	BENEFIT-COST RATIO
Base case: A = 84%, B = 58%	**$415.3**	**13.7%**	**3.7**
Scenario 1: A = 100%, B = 58%	$434.0	14.8%	4.3
Scenario 2: A = 84%, B = 100%	$497.1	22.3%	8.2
Scenario 3: A = 100%, B = 100%	$531.6	33.7%	16.2
Scenario 4: A = 0%, B = 0%	$316.5	9.4%	2.3

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

TABLE 4.4: Sensitivity analysis of discount rate

% VARIATION IN ASSUMPTION	-50%	-25%	-10%	BASE CASE	10%	25%	50%
STUDENT PERSPECTIVE							
Discount rate	2.1%	3.2%	3.9%	**4.3%**	4.7%	5.4%	6.4%
Net present value (millions)	$711	$543	$462	**$415**	$373	$317	$302
Benefit-cost ratio	5.7	4.6	4.1	**3.7**	3.5	3.1	3.0
TAXPAYER PERSPECTIVE							
Discount rate	0.4%	0.5%	0.6%	**0.7%**	0.8%	0.9%	1.1%
Net present value (millions)	$235	$223	$216	**$212**	$207	$201	$191
Benefit-cost ratio	3.8	3.7	3.6	**3.5**	3.5	3.4	3.3
SOCIAL PERSPECTIVE							
Discount rate	0.4%	0.5%	0.6%	**0.7%**	0.8%	0.9%	1.1%
Net present value (millions)	$3,372	$3,241	$3,165	**$3,115**	$3,067	$2,996	$2,882
Benefit-cost ratio	12.8	12.4	12.1	**11.9**	11.8	11.5	11.1

it. Typically, this minimum rate of return is determined by the known returns of less risky assets where the investors might alternatively consider placing their money.

In this study, we assume a 4.3% discount rate for students and a 0.7% discount rate for society and taxpayers.[41] Similar to the sensitivity analysis of the alternative education variable, we vary the base case discount rates for students, taxpayers, and society on either side by increasing the discount rate by 10%, 25%, and 50%, and then reducing it by 10%, 25%, and 50%. Note that, because the rate of return and the payback period are both based on the undiscounted cash flows, they are unaffected by changes in the discount rate. As such, only variations in the net present value and the benefit-cost ratio are shown for students, taxpayers, and society in Table 4.4.

As demonstrated in the table, an increase in the discount rate leads to a corresponding decrease in the expected returns, and vice versa. For example, increasing the student discount rate by 50% (from 4.3% to 6.4%) reduces the students' benefit-cost ratio from 3.7 to 3.0. Conversely, reducing the discount rate for students by 50% (from 4.3% to 2.1%) increases the benefit-cost ratio from 3.7 to 5.7. The sensitivity analysis results for society and taxpayers show the same inverse relationship between the discount rate and the benefit-cost ratio, with the variance in results being the greatest under the social perspective (from a 12.8 benefit-cost ratio at a -50% variation from the base case, to an 11.1 benefit-cost ratio at a 50% variation from the base case).

41 These values are based on the baseline forecasts for the 10-year Treasury rate published by the Congressional Budget Office and the real treasury interest rates recommended by the Office of Management and Budget for 30-year investments. See the Congressional Budget Office "Table 4. Projection of Borrower Interest Rates: CBO's January 2017 Baseline" and the Office of Management and Budget "Circular A-94 Appendix C."

RETAINED STUDENT VARIABLE

The retained student variable only affects the student spending impact calculation in Table 4.5, on the next page. For this analysis, we assume a retained student variable of 10%, which means that 10% of MCC's students who originated from the MCC Four County Service Area would have left the region for other opportunities, whether that be education or employment, if MCC did not exist. The money these retained students spent in the region for accommodation and other personal and household expenses is attributable to MCC.

Table 4.5 presents the results of the sensitivity analysis for the retained student variable. The assumption increases

TABLE 4.5: Sensitivity analysis of retained student variable

% VARIATION IN ASSUMPTION	-50%	-25%	-10%	BASE CASE	10%	25%	50%
Retained student variable	5%	8%	9%	**10%**	11%	13%	15%
Student spending impact (thousands)	$25,228	$29,795	$32,536	**$34,362**	$36,189	$38,929	$43,497

and decreases relative to the base case of 10% by the increments indicated in the table. The student spending impact is recalculated at each value of the assumption, holding all else constant. Student spending impacts attributable to MCC range from a high of $43.5 million when the retained student variable is 15% to a low of $25.2 million when the retained student variable is 5%. This means as the retained student variable decreases, the student spending attributable to MCC decreases. Even under the most conservative assumptions, the student spending impact on the MCC Four County Service Area economy remains substantial.