Demonstrating the Value of Algonquin College of Applied Arts and Technology

Analysis of the Economic Impact and Return on Investment of Education

May 2014

Economic Modeling Specialists Intl.

409 S. Jackson Street

Moscow, ID 83843

Tel: 208-883-3500

www.economicmodeling.com

Table of Contents

Acknowledgments

Economic Modeling Specialists International (EMSI) gratefully acknowledges the excellent support of the staff at Algonquin College of Applied Arts and Technology (Algonquin) in making this study possible. Special thanks go to Dr. Kent MacDonald, President, who approved the study; and to Duncan Topp, Manager, Institutional Research, who collected and organized much of the data and information requested. Any errors in the report are the responsibility of EMSI and not of any of the above-mentioned institutions or individuals.

Preface

Since 2002, Economic Modeling Specialists International (EMSI) has helped address a widespread need in the US, Canada, the UK, and Australia to demonstrate the impact of education. To date we have conducted more than 1,200 economic impact studies for educational institutions in North America and abroad. Along the way we have worked to continuously update and improve the model to ensure that it conforms to best practices and stays relevant in today's economy.

The present study reflects the latest version of our college impact model, representing the most up-to-date theory and practices for conducting human capital economic impact analysis. Among the most vital departures from EMSI's previous college impact model for Canada is the development of EMSI's Canadian Regional Input-Output (CRIO) model. The CRIO model draws from Statistics Canada and other sources to provide a unified source for economic information at the regional level. Moving to the more robust CRIO model allows us to increase the level of sectoral detail in the study and reduces any aggregation error that may have occurred under the previous framework. This change in methodology primarily affects the regional economic impact analysis provided in Chapter 2; however, the CRIO model also increases the accuracy with which we calculate the province-wide earnings and multiplier effects used in the investment analysis in Chapter 3.

The new college impact model also reflects significant changes to the calculation of the alternative education variable. This variable addresses the counterfactual scenario of what would have occurred if the publicly-funded institutions in the province did not exist, leaving the students to obtain an education elsewhere. The previous model used assumptions to estimate the variable depending on the size of the college region and the number of private institutions present there. The current model goes further and measures the distance between institutions and the associated differences in tuition prices to determine the change in the students' demand for education. This methodology is a more robust approach and significantly improves our estimate of alternative education opportunities.

Two additional improvements include the adjustment for substitution effects, which we apply in our calculation of the impact of past students' productivity; and our attrition module, which examines the movement of workers in and out of the regional and provincial workforce. The substitution effect was not applied in previous versions of the college impact model and is designed to account for the counterfactual scenario where the college does not exist and local employers have to recruit workers from outside the region. The attrition rate – though not new to the college impact model – was previously based on assumptions and is now drawn from death, retirement, unemployment, and migration rates from Statistics Canada and other sources, allowing for a more accurate, age-specific measurement of the number of individuals that leave the workforce over time.

These and other changes mark a considerable upgrade to the EMSI college impact model. With the CRIO model we have a more detailed view of the economy, enabling us to more accurately

determine regional economic impacts. Former assumptions have been replaced with observed data, as exemplified by the revision to the alternative education variable and the attrition rate. Further, we have researched the latest sources in order to update the background data with the most up-to-date data and information. Finally, we have revised and re-worked the documentation of our findings and methodology. Our hope is that these improvements will provide a better product to our clients—reports that are more transparent and streamlined, methodology that is more comprehensive and robust, and findings that are more relevant and meaningful to today's audiences. We encourage our readers to approach us directly with any questions or comments they may have about the study so that we can continue to improve our model and keep the public dialogue open about the positive impacts of education.

Introduction

Algonquin College of Applied Arts and Technology (Algonquin) creates value in many ways. The college plays a key role in helping students increase their employability and achieve their individual potential. With a wide range of program offerings, Algonquin enables students to earn credentials and develop the skills they need in order to have a fulfilling and prosperous career. The college also provides an excellent environment for students to meet new people and make friends, while participation in college courses improves the students' self-confidence and promotes their mental health. These social and employment-related benefits have a positive influence on the health and well-being of individuals.

However, the contribution of Algonquin consists of more than solely influencing the lives of students. The college's program offerings support a range of industry sectors in the Ottawa Region and supplies employers with the skilled workers they need to make their businesses more productive. The expenditures of Algonquin, along with the spending of its employees and its students, further support the local economy through the output and employment generated by local businesses. Lastly, and just as importantly, the economic impact of Algonquin extends as far as the provincial treasury in terms of increased tax receipts and decreased public sector costs.

Objective of the report

In this report we aim to assess the economic impact of Algonquin on the regional economy and the benefits generated by the college in return for the investments made by its key stakeholder groups: students, society, and the Ontario government. Our approach is twofold. We begin with an economic impact analysis of Algonquin on the local business community in the Ottawa Region. To derive results, we rely on EMSI's Canadian Regional Input-Output (CRIO) model to calculate the additional income created in the Ottawa Region economy as a result of college-linked input purchases, consumer spending, and the added skills of Algonquin students. Results of the regional economic impact analysis are broken out according to the following three effects: 1) impact of college operations, 2) impact of student spending, and 3) impact of the skills acquired by former students that are still active in the Ottawa Region workforce.

The second component of the study is a standard investment analysis to determine how money spent on Algonquin performs as an investment over time. The investors in this case are students, society, and the Ontario government, all of whom pay a certain amount in costs to support the educational activities at Algonquin. The students' investment consists of their out-of-pocket expenses and the opportunity cost of attending college as opposed to working. Society invests in education by forgoing the services that it would have received had government not funded Algonquin and the business output that it would have enjoyed had students been employed instead of studying. The Ontario government contributes their investment through government funding.

In return for these investments, students receive a lifetime of higher earnings, society benefits from an enlarged economy and a reduced demand for social services, and the Ontario government benefits from an expanded tax base and a collection of public sector savings. To determine the feasibility of the investment, the model projects benefits into the future, discounts them back to their present value, and compares them to their present value costs. Results of the investment analysis for students, society, and the Ontario government are displayed in the following four ways: 1) net present value of benefits, 2) rate of return, 3) benefit-cost ratio, and 4) payback period.

A wide array of data and assumptions are used in the study based on several sources, including the 2012-13 academic and financial reports from the college, Colleges Ontario, Ontario College Application Service (OCAS), the Ontario Ministry of Training, Colleges and Universities, as well as industry and employment data from Statistics Canada, outputs of EMSI's CRIO model, and a variety of published materials relating education to social behaviour. The study aims to apply a conservative methodology and follows standard practice using only the most recognized indicators of investment effectiveness and economic impact.

Effect of Applied Research

The Ontario government added applied research to its legislative mandate in 2002, leading the colleges to implement and provide expanded applied research and consulting services as well as offer more courses on entrepreneurial skills. In 2011-12, Ontario colleges reported working with 502 companies and industry partners on applied research projects and completed an additional 118 social innovation projects. These projects not only engaged students and faculty and provided them with experience, but also contributed to the colleges' income. Furthermore, the colleges used employer-led Program Advisory Committees to review their programs on a regular basis to ensure that the offerings reflect employers' needs.

The result has led to increased numbers of entrepreneurs and employees in Ontario who have provided innovative solutions for developing new and improved products, production processes, and so forth. In 2006, Statistics Canada estimated that 15% of employed Ontarians with a post-secondary education certificate were self-employed, just less than the 17% with a degree. For those college graduates not self-employed, they are more likely to work in the private sector, in small to medium sized enterprises, and in their home communities compared to those with university degrees. The applied research experience the students receive at Ontario colleges lead them to help their organizations become more innovative and competitive. While these specific benefits are not explicitly captured in the analysis, it is recognized that they lead to increased economic benefits.

Notes of importance

There are two notes of importance that readers should bear in mind when reviewing the findings presented in this report. First, this report is not intended to be a vehicle for comparing Algonquin with other publicly-funded institutions in the province or elsewhere. Other studies comparing the

gains in income and social benefits of one institution relative to another address such questions more directly and in greater detail. Our intent is simply to provide the Algonquin management team and stakeholders with pertinent information should questions arise about the extent to which Algonquin impacts the regional economy and generates a return on investment. Differences between the results for Algonquin and those of other institutions, however, do not necessarily indicate that one institution is doing a better job than another. Results are a reflection of location, student body profile, and other factors that have little or nothing to do with the relative efficiency of the institutions. For this reason, comparing results between institutions or using the data to rank institutions is strongly discouraged.

Second, this report is useful in establishing a benchmark for future analysis, but it is limited in its ability to put forward recommendations on what Algonquin can do next. The implied assumption is that the college can effectively improve its results if it increases the number of students it serves, helps students to achieve their educational goals, and remains responsive to employer needs in order to ensure that students find meaningful jobs after exiting. Establishing a strategic plan for achieving these goals, however, is not the purpose of this report.

Key findings

The results of this study show that Algonquin has a significant positive impact on the business community in the regional economy and generates benefits in return for the investments made by its main stakeholder groups: students, society, and the Ontario government. Using a two-pronged approach that involves a regional economic impact analysis and an investment analysis, we calculate the benefits to each of these groups. Key findings of the study are as follows:

Economic impact on regional economy

- Algonquin employed **2,432** full-time equivalent (FTE) employees in 2012-13. Payroll amounted to **$149.5 million**, much of which was spent in the Ottawa Region to purchase groceries, clothing, and other household goods and services. Algonquin is itself a buyer of goods and services and spent **$115.0 million** to support its operations in 2012-13. The net impact of Algonquin payroll and expenses in the Ottawa Region was approximately **$207.3 million** in added income in FY 2012-13.

- A total of **6,106** students relocated to the Ottawa Region from outside the region and spent money at local businesses to buy books and supplies, purchase groceries, rent accommodation, pay for transport, attend sporting events, and so on. These expenditures added approximately **$28.4 million** in income to the Ottawa Region economy in FY 2012-13.

- Approximately **75%** of students who attended Algonquin stay in the Ottawa Region after exiting the college. Their enhanced skills and abilities bolster the output of local employers, leading to higher regional income and a more robust economy. The accumulated

contribution of former Algonquin students who were employed in the regional workforce in FY 2012-13 amounted to **$1.6 billion** in added income in the Ottawa Region economy.

- The total effect of Algonquin on the local business community in the Ottawa Region in FY 2012-13 was **$1.8 billion**, approximately equal to **3.2%** of the region's Gross Regional Product.

Return on investment to students, society, and the Ontario government

- Students paid a total of **$84.3 million** to cover the cost of tuition and fees and books and supplies at Algonquin in 2012-13. They also forwent **$305.4 million** in earnings that they would have generated had they been working instead of learning.
- In return for the monies invested in Algonquin, students receive a present value of **$1.7 billion**, net of income taxes, in increased earnings over their working lives. This translates to a return of **$4.50** in higher future earnings for every $1 that students pay for their education at Algonquin. The corresponding internal rate of return is **19.5%**.
- Society as a whole in the province of Ontario will receive a present value of **$5.6 billion** in added provincial income over the course of the students' working lives. Society will also benefit from **$45.0 million** in present value social savings related to reduced crime, lower unemployment, and increased health and well-being across the province.
- For every dollar funded by society and spent by Algonquin in FY 2012-13, society as a whole will receive a cumulative value of **$21.30** in benefits, for as long as the 2012-13 Algonquin student population remains active in the provincial workforce.
- Provincial government paid **$147.3 million** to support the operations of Algonquin in 2012-13, including provincial grants and the capital costs of provincial loans. The net present value of the added tax revenue stemming from the students' higher lifetime earnings and the increased output of businesses amounts to **$889.2 million** in benefits to the Ontario government. Savings to the public sector add another **$18.1 million** in benefits due to a reduced demand for government-funded social services in Ontario.
- Dividing the benefits to the Ontario government by the amount that it paid to support Algonquin yields a **6.2** benefit-cost ratio, *i.e.*, every $1 in costs returns **$6.20** in benefits. In other words, the Ontario government fully recovers the cost of the original investment and also receives a return of **$5.20** in addition to every dollar paid. The average annual internal rate of return for the Ontario government is **24.1%**.

Chapter 1: Profile of Algonquin and the Regional Economy

Estimating the benefits and costs of Algonquin requires three types of information: (1) employee and finance data, (2) student demographic and achievement data, and (3) the economic profile of the region and the province. For the purpose of this study, information on the college and its students was obtained from Algonquin, and data on the regional and provincial economy were drawn from EMSI's proprietary data modeling tools.

1.1 Employee and finance data

1.1.1 Employee data

Data provided by Algonquin include information on college employees by place of work and by place of residence. These data appear in Table 1.1. As shown, 2,432 full-time equivalent employees worked at Algonquin in FY 2012-13. Of these, 99% worked in the Ottawa Region and 92% lived in the region. These data are used to isolate the portion of the employees' household expenses that remains in the local economy.

Table 1.1: Employee data, FY 2012-13

Total full-time equivalent employees	2,432
% of employees that work in region	99%
% of employees that live in region	92%

Source: Data supplied by OCAS and Algonquin.

1.1.2 Revenues

Table 1.2 shows Algonquin's annual revenues by funding source—a total of $270.5 million in FY 2012-13. As indicated, aggregate tuition and ancillary fees comprised 33.0% of total revenue, revenue from provincial grants and contracts 47.8%, revenue from federal grants and contracts less than 1.0%, and all other non-government revenue (*i.e.*, sales, donations, residences, and non-government grants and contracts) the remaining 19.1%. These data are critical in identifying annual costs of educating the student body from the perspectives of students and the Ontario government.

Table 1.2: Revenue by source, FY 2012-13

Funding source	Total	%
College revenues		
Aggregate tuition and ancillary fees	$89,309,154	33.0%
Domestic contractual and other fees for services	$13,628,390	5.0%
International contractual and other fees for services	$364,939	0.1%
Provincial grants and contracts	$129,386,475	47.8%
Federal grants and contracts	$25,000	<1.0%
Residence revenue	$8,562,153	3.2%
Sales	$25,954,284	9.6%
Other non-government revenue	$3,260,670	1.2%
Total college revenues	**$270,491,065**	**100.0%**

Source: Data supplied by Algonquin.

1.1.3 Expenditures

Algonquin's combined payroll amounted to $149.5 million, equal to 56.5% of the college's total expenses for FY 2012-13. Other expenditures, including capital and purchases of supplies and services, made up $115 million. These budget data appear in Table 1.3.

Table 1.3: Expenses by function, FY 2012-13

Expense item	Total	%
Employee payroll	$149,478,200	56.5%
Capital depreciation	$14,728,114	5.6%
All other expenditures	$100,231,328	37.9%
Total expenses	**$264,437,642**	**100.0%**

Source: Data supplied by Algonquin.

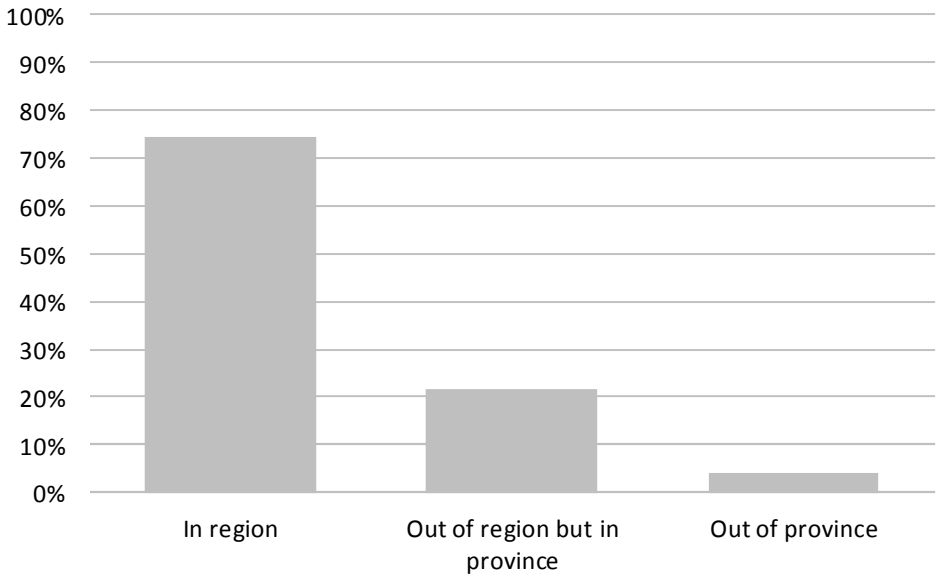
1.2. Student profile data

1.2.1 Demographics

Algonquin served 24,230 total students in the 2012-13 reporting year, including funded, international, Second Career, and other unfunded students. The breakdown of the student body by gender was 53% male and 47% female. The students' overall average age was 25.

Figure 1.1 presents the settlement patterns of Algonquin students after exiting the college. As indicated, 75% of students remain in the Ottawa Region. Another 22% of students settle outside the region but in the province, and the remaining 4% settle outside the province.

Figure 1.1: Student settlement patterns



1.2.2 Achievements

Table 1.4 summarizes the breakdown of the student population by credential type and the corresponding number of full-time equivalents (FTEs). FTEs are used to standardize actual course loads against normal course loads in order to combine full-time and part-time student counts. FTE data combined with the number of credentials issued are key to determining how far students advance in their education during the analysis year and the associated value of their achievements.

As indicated, Algonquin served 671 graduate certificate students, 395 bachelor's degree students, 13,515 diploma students, and 3,485 certificate students. Algonquin also served 3,118 apprenticeship students. Another 945 students pursued academic upgrading credentials, such as the high school diploma or ESL certificate.

A total of 1,143 students enrolled in personal enrichment programs or courses. In the analysis, we exclude personal enrichment students and their corresponding FTE production under the assumption that they do not attain workforce skills that will increase their lifetime earnings. All other students – including those enrolled in non-credential workforce and career-oriented courses – comprised the remaining 958 students.

Table 1.4: Breakdown of student population by credential type, 2012-13

Category	Unduplicated Headcount	FTEs	Average FTEs per student	Number of Credentials Issued
Graduate certificate	671	697	1.04	583
Bachelor's degree	395	411	1.04	67
Diploma	13,515	14,052	1.04	4,794
Certificate	3,485	3,624	1.04	1,431
Apprenticeship	3,118	668	0.21	N/A
Developmental	945	612	0.65	457
Personal enrichment	1,143	343	0.30	N/A
Other	958	392	0.41	144
Total, all students	**24,230**	**20,799**	**0.86**	**7,476**
Total, less personal enrichment	**23,087**	**20,456**	**0.89**	**7,476**

Source: Data supplied by Algonquin.

Altogether, Algonquin had 24,230 enrolments and issued 7,476 credentials during the analysis year. The total FTE production for the student population (excluding personal enrichment students) was 20,456 FTEs, for an overall average of 0.89 FTEs per student.

1.3 Regional profile data

1.3.1 Gross Regional Product

Table 1.5 summarizes the breakdown of the Ottawa Region economy[1] by major industrial sector, with details on earnings, other income, and Gross Regional Product (GRP). Earnings include the wages and salaries of employees (excluding self-proprietors), and other income includes operating surplus, mixed income, and taxes less subsidies on production, products and imports. Together earnings and other income make up the region's total GRP. In Chapter 2, we use GRP as the backdrop against which we measure the relative impacts of the college on economic growth in the region. As shown in Table 1.5, total GRP in the Ottawa Region is approximately $56.7 billion, equal to $30.9 billion in earnings plus $25.8 billion in other income.

[1] The Ottawa Region is defined as Ottawa Division, Renfrew County, Lanark County, and Prescott and Russell United Counties.

Table 1.5: Earnings, other income, and Gross Regional Product (GRP) by major industrial sector in the Ottawa Region, 2012-13

Industry sector	Earnings (millions)	Other income (millions)	Total GRP (millions)	% of Total
Agriculture, forestry, fishing and hunting	$69	$275	$344	0.6%
Mining, quarrying, and oil and gas extraction	$48	$98	$146	0.3%
Utilities	$203	$509	$713	1.3%
Construction	$1,557	$1,474	$3,031	5.3%
Manufacturing	$1,754	$1,644	$3,398	6.0%
Wholesale trade	$1,229	$750	$1,979	3.5%
Retail trade	$1,655	$971	$2,626	4.6%
Transportation and warehousing	$1,108	$317	$1,425	2.5%
Information and cultural industries	$1,034	$1,368	$2,402	4.2%
Finance and insurance	$631	$1,197	$1,828	3.2%
Real estate and rental and leasing	$250	$6,536	$6,787	12.0%
Professional, scientific, and technical services	$3,252	$1,145	$4,397	7.8%
Management of companies and enterprises	$735	$869	$1,604	2.8%
Administrative and support, waste management and remediation services	$1,088	$515	$1,603	2.8%
Educational services	$2,143	$780	$2,923	5.2%
Health care and social assistance	$2,682	$890	$3,572	6.3%
Arts, entertainment, and recreation	$253	$180	$433	0.8%
Accommodation and food services	$615	$434	$1,049	1.8%
Other services (except public administration)	$1,134	$207	$1,341	2.4%
Public administration	$9,494	$5,609	$15,104	26.6%
Total	**$30,935**	**$25,769**	**$56,704**	**100.0%**

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

† Numbers may not add due to rounding.

Source: EMSI CRIO model.

1.3.2 Jobs by industry

Table 1.6 provides the breakdown of jobs by industry in the Ottawa Region. The "Health care and social assistance" industry is the region's largest employer, supporting 71,395 jobs or 10.6% of total employment. The second largest employer is the "Retail trade" industry, supporting 67,124 jobs or 9.9% of total employment. Altogether, the region supports 674,902 jobs.[2]

[2] Job numbers reflect both wage and salary employees and self-employed workers.

Table 1.6: Jobs by major industrial sector in the Ottawa Region, 2012-13

Industry sector	Total jobs	% of total
Agriculture, forestry, fishing and hunting	6,679	1.0%
Mining, quarrying, and oil and gas extraction	715	0.1%
Utilities	2,643	0.4%
Construction	38,231	5.7%
Manufacturing	32,213	4.8%
Wholesale trade	21,098	3.1%
Retail trade	67,124	9.9%
Transportation and warehousing	22,931	3.4%
Information and cultural industries	17,478	2.6%
Finance and insurance	12,407	1.8%
Real estate and rental and leasing	8,393	1.2%
Professional, scientific, and technical services	67,102	9.9%
Management of companies and enterprises	18,857	2.8%
Administrative and support, waste management and remediation services	35,578	5.3%
Educational services	42,788	6.3%
Health care and social assistance	71,395	10.6%
Arts, entertainment, and recreation	12,335	1.8%
Accommodation and food services	38,674	5.7%
Other services (except public administration)	32,824	4.9%
Public administration	125,437	18.6%
Total	**674,902**	**100.0%**

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

† Numbers may not add due to rounding.

Source: EMSI CRIO model.

1.3.3 Earnings by education level

Table 1.7 and Figure 1.2 present the average earnings by education level in the Ottawa Region at the midpoint of the average-aged worker's career. These numbers are derived from data supplied by Statistics Canada, grown to reflect current year dollars, and regionalized using a scalar derived from average earnings per worker in the Ottawa Region.

As shown, students who achieve a two-year diploma can expect $36,100 in earnings per year, approximately $13,500 more than someone with a high school diploma. The difference between a high school diploma and the attainment of a bachelor's degree is even greater – up to $22,600 in higher income.

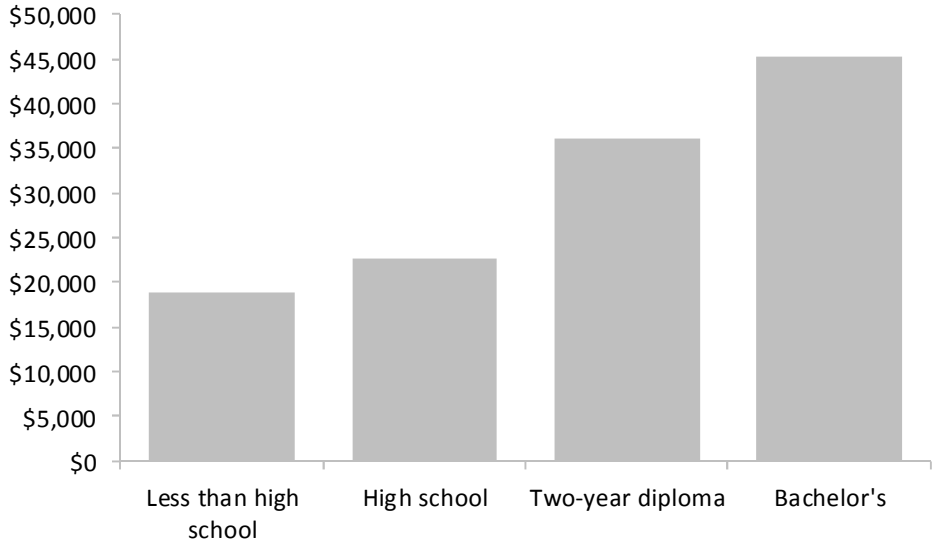
Table 1.7: Expected earnings in the Ottawa Region at midpoint of individual's working career by education level

Education level	Income	Difference
Less than high school	$18,800	n/a
High school or equivalent	$22,600	$3,800
Two-year diploma	$36,100	$13,500
Bachelor's degree	$45,200	$9,100

* The earnings data represents median after-tax income for full year and part year, full-time and part-time workers, as well as those who received government assistance (such as employment insurance).

Source: Derived from data supplied by Statistics Canada and the EMSI CRIO model.

Figure 1.2: Expected income by education level at career midpoint



1.4 Conclusion

This chapter presents the broader elements of the database used to determine the results. Additional detail on data sources, assumptions, and general methods underlying the analyses are conveyed in the remaining chapters and appendices. The core of the findings is presented in the next two chapters— Chapter 2 considers Algonquin's impact on the regional economy, and Chapter 3 looks at Algonquin as an investment. The appendices detail a collection of miscellaneous theory and data issues.

Chapter 2: Economic Impact Analysis

Algonquin impacts the Ottawa Region in a variety of ways. The college is an employer and a buyer of goods and services. It attracts monies to the region that would not have otherwise entered the local economy through its own revenue stream and through the expenditures of non-local students. Further, as a primary source of education to local residents, Algonquin supplies trained workers to business and industry and contributes to associated increases in regional output.

In this chapter we track Algonquin's regional economic impacts under three headings: (1) the college operations effect, stemming from Algonquin's payroll and purchases; 2) the student spending effect, due to the spending of non-local students for room and board and other personal expenses, and (3) the past students' productivity effect, comprising the added income created in the region as former Algonquin students expand the economy's stock of human capital.

2.1 College operations effect

Nearly all of Algonquin's employees live in the Ottawa Region (see Table 1.1). Employee earnings count as part of the region's overall income, while their spending for groceries, apparel, and other household expenditures helps support local businesses. In addition to being an employer, Algonquin is also a purchaser of supplies and services. Many of Algonquin's vendors are located in the Ottawa Region, creating a ripple effect that generates still more jobs and income throughout the economy.

Table 2.1 presents the economic impact of Algonquin operations. The top row shows total earnings and other income in the Ottawa Region, which together make up the region's total income or Gross Regional Product (GRP). These data match the figures provided in Table 1.5 of Chapter 1.

Table 2.1: College operations effect

	Earnings (thousands)	Other income (thousands)	GRP (thousands)	% of total GRP
Total income in region	$30,934,998	$25,769,118	$56,704,117	100.0%
Initial effect	**$147,983**	**$0**	**$147,983**	**0.3%**
Multiplier effect				
Direct effect	$20,705	$13,412	$34,117	<0.1%
Indirect effect	$4,776	$3,493	$8,269	<0.1%
Induced effect	$20,464	$17,269	$37,732	<0.1%
Total multiplier effect	**$45,945**	**$34,174**	**$80,119**	**0.1%**
Gross effect (initial + multiplier)	**$193,928**	**$34,174**	**$228,102**	**0.4%**
Less alternative uses of funds	-$10,727	-$10,086	-$20,813	<0.1%
Net effect	**$183,201**	**$24,088**	**$207,289**	**0.4%**

Source: EMSI CRIO model.

As for the impacts themselves, we follow best practice and draw the distinction between initial effects and multiplier effects. The initial effect of Algonquin operations is simple—it amounts to

$148 million in college payroll, less monies paid to employees who live outside the region). Total college payroll appeared in the list of college expenditures reported in Table 1.3. Note that, as a public entity, Algonquin does not generate other (*i.e.*, non-earnings) income in the traditional sense, so the amount of other income associated with college operations under the initial effect is zero.

Multiplier effects refer to the additional income created in the economy as Algonquin and its employees spend money in the region. They are categorized according to the following three effects: the direct effect, the indirect effect, and the induced effect. Direct effects refer to the income created by the supply chain of the industries initially affected by the spending of Algonquin and its employees. Indirect effects occur as the supply chain of the initial supply chain creates even more income in the region. Finally, induced effects refer to the income created by the increased spending of the household sector as a result of the direct and indirect effects.

Calculating multiplier effects requires the use of EMSI's Canadian Regional Input-Output (CRIO) model that captures the interconnection of industries, government, and households in the region. The EMSI CRIO model contains 91 industry sectors from the North American Industry Classification System (NAICS) and supplies the industry-specific multipliers required to determine the impacts associated with economic activity within the region. For more information on the EMSI CRIO model and its data sources, see Appendix 3.

Table 1.3 in Chapter 1 breaks Algonquin's expenditures into the following three categories: payroll, capital depreciation, and all other expenditures (including purchases for supplies and services). The first step in estimating the multiplier effect of these expenditures is to map them individually to the 91 industry sectors of the EMSI CRIO model. Assuming that the spending patterns of college personnel approximately match those of the average consumer, we map college payroll to spending on industry outputs using national household expenditure coefficients supplied by EMSI's national CRIO model. For the other two expenditure categories (*i.e.*, capital depreciation and all other expenditures), we again assume that the college's spending patterns approximately match national averages and apply the national spending coefficients for the "Educational services (except universities)" industry sector (NAICS 611B0). Capital depreciation is mapped to the construction sectors of NAICS 611B0 and the college's remaining expenditures to the non-construction sectors of NAICS 611B0.

We now have three vectors detailing the spending of Algonquin: one for college payroll, another for capital items, and a third for Algonquin's purchases of supplies and services. Before entering these items into the CRIO model, we factor out the portion of them that occurs locally. Each of the approximately 91 sectors in the CRIO model is represented by a regional purchase coefficient (RPC), a measure of the overall demand for the commodities produced by each sector that is satisfied by local suppliers. For example, if 40% of the demand for NAICS 52410 ("Insurance carriers") is satisfied by local suppliers, the RPC for that sector is 40%. The remaining 60% of the demand for NAICS 52410 is provided by suppliers located outside the region. The three college

spending vectors are thus multiplied sector-by-sector by the corresponding RPC for each sector to arrive at the strictly local spending associated with the college.

Local spending is entered into the CRIO model's multiplier matrix, which in turn provides an estimate of the associated multiplier effects on regional sales. We convert the sales figures to income using income-to-sales ratios, also provided by the CRIO model. Final results appear in the section labeled "Multiplier effect" in Table 2.1. Altogether, Algonquin's spending creates $45.9 million in earnings and another $34.2 million in other income through multiplier effects—a total of $80.1 million. This together with the $148 million in initial effects generates a gross total of $228.1 million in impacts associated with the spending of Algonquin and its employees in the region.

Here we make a significant qualification. Algonquin received an estimated 39.3% of its funding from sources in the Ottawa Region. These monies came from students living in the region, from private sources, and from the local share of provincial taxes.[3] Had other industries received these monies rather than Algonquin, income effects would have still been created in the economy. This scenario is commonly known as a counterfactual outcome, *i.e.*, what has not happened but what would have happened if a given event – in this case, the expenditure of local funds on Algonquin – had not occurred. In economic analysis, impacts that occur under counterfactual conditions are used to offset the impacts that actually occur in order to derive the true impact of the event under analysis.

For Algonquin, we calculate counterfactual outcomes by modeling the local monies spent on the college as regular spending on consumer goods and savings. Our assumption is that, had students not spent money on the college, they would have used that money instead to buy consumer goods. Similarly, had the monies that taxpayers spent on Algonquin been returned to them in the form of a tax decrease, we assume that they too would have spent that money on consumer goods. Our approach, therefore, is to establish the total amount spent by local students and taxpayers on Algonquin, map this to the detailed sectors of the CRIO model using national household expenditure coefficients, and scale the spending vector to reflect the change in local spending only. Finally, we run the local spending through the CRIO model's regional multiplier matrix to derive initial and multiplier effects, and then we convert the sales figures to income. The effects of this new consumer spending are shown as negative values in the row labeled "Less alternative uses of fund" in Table 2.1.

The net total income effect of Algonquin spending can now be computed. As shown in the last row of Table 2.1, the net effect is approximately $183.2 million in earnings and $24.1 million in other income. The overall total is $207.3 million, representing the added income created in the regional economy as a result of Algonquin operations.

---

[3] Local taxpayers pay provincial taxes, and it is thereby fair to assume that a portion of the provincial funds received by Algonquin comes from local sources. The portion of provincial taxes paid by local taxpayers is estimated by applying the ratio of regional earnings to total earnings in the province.

2.2 Student spending effect

A total of 6,106 of Algonquin's students relocated to the Ottawa Region to attend college in FY 2012-13. These students spent money at local businesses to purchase groceries, rent accommodation, pay for transportation, and so on. The expenditures of Algonquin's non-local students supported local jobs and created new income in the regional economy.[4]

The average living expenses of students who relocated to the Ottawa Region appears in the first section of Table 2.2, equal to $14,348 per student per year. Note that this figure excludes expenses for books and supplies, since many of these monies are already reflected in the operations effect discussed in the previous section. Multiplying the $14,348 in annual costs by the number of students who relocated to the region generates gross sales of $87.6 million.

Table 2.2: Average annual student cost of attendance and total sales generated by Algonquin's non-local students in the Ottawa Region, 2012-13

Room and board	$9,398
Personal expenses	$4,150
Transportation	$800
Total expenses per student (A)	**$14,348**
Number of Algonquin students who relocated to region (B)	6,106
Gross sales generated by students who relocated (A*B)	$87,608,314

* Numbers may not add due to rounding.

Source: Data on the cost of attendance and the number of students who relocate estimated by Algonquin and EMSI.

Estimating the impacts generated by the $87.6 million in student spending follows a procedure similar to that of the operations effect described above. We begin by mapping the $87.6 million in sales to the industry sectors in the CRIO model, apply RPCs to reflect local spending only, and run the net sales figures through the CRIO model to derive multiplier effects. Finally, we convert the results to income through the application of income-to-sales ratios.

Table 2.3 presents the results. The initial effect is $0 because the impact of non-local students only occurs when they spend part of their earnings to make a purchase at a local business. Otherwise, the students' earnings have no impact on the local economy. The impact of non-local student spending thus falls entirely under the multiplier effect, equal to a total of $28.4 million in added regional income. This value represents the direct added income created at the businesses patronized by the students, the indirect added income created by the supply chain of those businesses, and the increased spending of the household sector throughout the regional economy as a result of the direct and indirect effects.

[4] Online students and students who commute to the Ottawa Region are not considered in this calculation because their living expenses predominantly occur in the region where they reside.

Table 2.3: Student spending effect

	Earnings (thousands)	Other income (thousands)	GRP (thousands)	% of total GRP in region
Total income in region	$30,934,998	$25,769,118	$56,704,117	100.0%
Initial effect	**$0**	**$0**	**$0**	**<0.1%**
Multiplier effect				
Direct effect	$8,308	$10,276	$18,584	<0.1%
Indirect effect	$2,247	$2,751	$4,998	<0.1%
Induced effect	$2,036	$2,813	$4,849	<0.1%
Total multiplier effect	**$12,590**	**$15,841**	**$28,431**	**<0.1%**
Total effect (initial + multiplier)	**$12,590**	**$15,841**	**$28,431**	**<0.1%**

Source: EMSI CRIO model.

2.3 Past students' productivity effect

Algonquin's greatest economic impact stems from the education, skills training, and career enhancement that it provides. Since it was established, the college has supplied skills training to students who have subsequently entered or re-entered the regional workforce. As these skills accumulated, the stock of human capital in the Ottawa Region expanded, boosting the competiveness of existing industries, attracting new industries, and generally enlarging overall output. The sum of all these several and varied effects, measured in terms of added regional income, constitutes the total impact of current and past Algonquin past students' productivity on the Ottawa Region economy.

The past students' productivity effect differs from the college operations effect and the student spending effect in one fundamental way. Whereas the effects of college operations and student spending depend on an annually-renewed injection of new sales in the local economy, the past students' productivity effect is the result of years of past instruction and the associated workforce accumulation of Algonquin skills. Should Algonquin cease to exist, the college operations effect and the student spending effect would also immediately cease to exist; however, the impact of the college's former students would continue, as long as those students remained active in the workforce. Over time, though, students would leave the workforce, and the expanded economic output that they provided through their increased productivity would leave with them.

The initial effect of past students' productivity comprises two main components. The first and largest of these is the added earnings (*i.e.*, wages and salaries) of former Algonquin students. Higher wages occur as the increased productivity of workers leads to greater business output. The reward to increased productivity does not stop there, however. Skilled workers make capital goods (*e.g.*, buildings, production facilities, equipment, *etc.*) more productive too, thereby increasing the return on capital in the form of higher profits. The second component of the initial effect thus comprises the other (*i.e.*, non-earnings) income generated by the businesses that employ former Algonquin students.

The first step in estimating the initial effect of past students' productivity is to determine the added earnings that accrue to students. We begin by assembling the record of Algonquin's historical student FTEs (both credit and non-credit) over the past 30 years,[5] from 1983-84 to 2012-13. From this vector of historical student FTEs we remove the number not currently active in the regional workforce, whether because the students are still enrolled in education, or because they're unemployed, employed but working in a different region, or out of the workforce completely due to retirement or death. We estimate the historical employment patterns of students in the region using the following sets of data or assumptions: 1) a set of settling-in factors to determine how long it takes the average student to settle into a career;[6] 2) death, retirement, and unemployment rates from Statistics Canada; and 3) regional migration data, also from Statistics Canada. The end result of these several computations is an estimate of the portion of student FTEs who were still actively employed in the region as of FY 2012-13. We are then able to use the number of student FTEs who were still employed in the region as a proxy for accumulated skills since FTEs represent the students' course load. The end product – 293,758 FTEs – appears in the top row of Table 2.4.

Table 2.4: Number of Algonquin FTEs still active in workforce and added earnings created in region

Number of FTEs in workforce	293,758
Average value per FTE	$5,674
Added earnings, gross	**$1,666,710,690**
Percent reduction for alternative education opportunities	23%
Percent reduction for adjustment for substitution	50%
Added earnings, net	**$638,449,016**

Source: EMSI college impact model.

The next row in Table 2.4 shows the average value per FTE, equal to $5,674. This value represents the average increase in wages that former Algonquin students received during the analysis year for every FTE generated at the college. The value per FTE varies depending on the students' age, with the highest value applied to the FTE production of students who had been employed the longest by FY 2012-13, and the lowest value per FTE applied to students who were just entering the workforce. More information on the theory and calculations behind the value per FTE appears in Appendix 4. In determining the amount of added earnings that accrue to former students, we sum the FTE production of Algonquin's former students in each year of the historical time horizon

[5] We apply a 30-year time horizon because the data on students who attended Algonquin prior to 1983-84 is less reliable, and because most of the students whom Algonquin served more than 30 years ago had left the regional workforce by FY2012-13.

[6] Settling-in factors are used to delay the onset of the benefits to students in order to allow time for them to find employment and settle into their careers. In the absence of hard data, we assume a range between one and three years for students who graduate with a credential, and between one and five years for continuing students. Workforce and professional development students are usually already employed while attending college, so they experience no delay in the onset of their benefits.

together. This calculation yield approximately $1.7 billion in gross higher wages received by former students in FY 2012-13 (as shown in Table 2.4).

The next two rows in the table show two adjustments that we make to account for counterfactual outcomes. As discussed above, counterfactual outcomes in economic analysis represent what would have happened if a given event had not happened. The event in this case is the training provided by Algonquin and subsequent influx of skilled labour into the local economy. The first counterfactual scenario that we address is the adjustment for alternative education opportunities. Our assumption is that, if a portion of the students could have received training even if Algonquin and the other publicly-funded institutions in the province did not exist, the higher wages that accrue to those students cannot be counted as added earnings in the region. The adjustment for alternative education opportunities amounts to a 23% reduction of the $1.7 billion in added earnings, meaning that 23% of the added earnings would have been generated in the region anyway, even if Algonquin did not exist. For more information on the calculation of the alternative education variable, see Appendix 5.

The other adjustment in Table 2.4 accounts for the substitution of workers. Suppose Algonquin did not exist and in consequence there were fewer skilled workers in the region. Businesses could still satisfy some of their need for skilled labour by recruiting from outside the Ottawa Region. We refer to this phenomenon as the out-of-region worker substitution effect. Lacking exact information on its possible magnitude, we set the value of out-of-region worker substitution at 50%. In other words, of the jobs that students fill at local businesses, we assume 50% of them could have been filled by workers recruited from outside the region if Algonquin did not exist.[7] With the 50% adjustment, the net added earnings in the economy come to $638.4 million, as shown in Table 2.4.

The $638.4 million in added earnings appears under the initial effect in the "Earnings" column of Table 2.5. Estimating the industry-specific effects on other income in the region – and the related multiplier effects – requires information on the specific industries where past students settle. While this information is not generally available, it is possible to build a sub-model that provides a plausible distribution of students across the 91 industry sectors of the CRIO model.

The sub-model relies on three assumptions. First, students with their newly acquired skills tend to locate in higher paying industries, so the sub-model weights industries according to their average wages, and directs more students to higher than to lower paying industries. Second, the larger an industry in a region the greater the number of students it will attract, so the sub-model weights industries according to size, and directs more students to larger rather than smaller industries. Finally, students will be drawn to the more technically advanced industries, so the sub-model weights industries according to their technical advance, and directs more students to advanced, as

[7] For a sensitivity analysis of the substitution variable, see Chapter 4.

opposed to less advanced, industries. This is done based on theory of economic development as a process of progressive stages outlined by Parr (1999).[8]

Once students are distributed across the 91 industry sectors of the CRIO model, we multiply our estimate of the students' initial earnings effect ($638.4 million) by the ratio of other income to earnings provided by the CRIO model for each sector. This computation yields an estimated $426.7 million in other income attributable to the former Algonquin students. Summing initial earnings and other income together provides the total initial effect of past students' productivity in the Ottawa Region economy, equal to approximately $1.1 billion.

Table 2.5: Past students' productivity effect

	Earnings (thousands)	Other income (thousands)	GRP (thousands)	% of total GRP in region
Total income in region	$30,934,998	$25,769,118	$56,704,117	100.0%
Initial effect	**$638,449**	**$426,747**	**$1,065,196**	**1.9%**
Multiplier effect				
Direct effect	$83,149	$67,021	$150,170	0.3%
Indirect effect	$20,424	$17,055	$37,479	<0.1%
Induced effect	$197,622	$130,582	$328,203	0.6%
Total multiplier effect	**$301,194**	**$214,657**	**$515,852**	**0.9%**
Total effect (initial + multiplier)	**$939,643**	**$641,405**	**$1,581,048**	**2.8%**

Source: EMSI CRIO model.

The next few rows of Table 2.5 show the multiplier effects of past students' productivity. Multiplier effects occur as students generate an increased demand for consumer goods and services through the expenditure of their higher wages. Further, as the industries where Algonquin students are employed increase their output, there is a corresponding increase in the demand for input from the industries in the employers' supply chain. Together, the incomes generated by the expansions in business input purchases and household spending constitute the multiplier effect of the increased productivity of former Algonquin students.

To estimate multiplier effects, we convert the industry-specific income figures generated through the initial effect to regional sales using sales-to-income ratios from the CRIO model. We then run the values through the CRIO model's multiplier matrix to determine the corresponding increases in industry output that occur in the region. Finally, we convert all increases in regional sales back to income using the income-to-sales ratios supplied by the CRIO model. The final results are $301.2 million in earnings and $214.7 million in other income, for an overall total of $515.9 million in multiplier effects. The grand total impact of past students' productivity thus comes to $1.6 billion, the sum of all initial and multiplier effects. The total figures appear in the last row of Table 2.5.

[8] J.B. Parr, "Regional Economic Development: An Export Stages Framework," *Land Economics* 77, no. 1 (1999): 94–114.

2.4 Summary of income effects

Table 2.6 displays the grand total of Algonquin's impact on the Ottawa Region in FY 2012-13, including the college operations effect, the student spending effect, and the past students' productivity effect.

Table 2.6: Total effect

	Total (thousands)	% of Total
Total income in region	$56,704,117	100.0%
College operations effect	$207,289	0.4%
Student spending effect	$28,431	<0.1%
Past students' productivity effect	$1,581,048	2.8%
Total	**$1,816,768**	**3.2%**

Source: EMSI CRIO model.

These results demonstrate several important points. First, Algonquin promotes regional economic growth through its own operations spending, the spending of its non-local students, and through the increase in productivity as former Algonquin students remain active in the regional workforce. Second, the past students' productivity effect is by far the largest and most important impact of Algonquin, stemming from the higher earnings and other income of students and their employers. And third, regional income in the Ottawa Region would be substantially lower without the educational activities of Algonquin.

Calculating Job Equivalents Based on Income

In this study the impacts of Algonquin on the regional economy are expressed in terms of income, specifically, the added income that would not have occurred in the region if the college did not exist. Added income means that there is more money to spend, and increased spending means an increased demand for goods and services. Businesses hire more people to meet this demand, and thus jobs are created.

Not every job is the same, however. Some jobs pay more, others less. Some are full-time, others are part-time. Some jobs are year-round, others are temporary. Deciding what constitutes an actual job, therefore, is difficult to do. To address this problem, this study counts all jobs equally and reports them in terms of job equivalents, i.e., the number of average-wage jobs in the region that a given amount of income could potentially support. Job equivalents are calculated by dividing the added income created by the college and its students by the average earnings per worker in the region.

Based on the added income figures from Table 2.6, the job equivalents supported by the activities of Algonquin and its students are as follows:

- *College operations effect = **3,960** job equivalents*
- *Student spending effect = **543** job equivalents*
- *Past students' productivity effect = **30,204** job equivalents*

*Overall, the income created by Algonquin during the analysis year supports **34,707** average-wage jobs in the region.*

Chapter 3: Investment Analysis

Investment analysis is the process of evaluating total costs and measuring these against total benefits to determine whether or not a proposed venture will be profitable. If benefits outweigh costs, then the investment is worthwhile. If costs outweigh benefits, then the investment will lose money and is thus considered infeasible.

In this chapter, we consider Algonquin as an investment from the perspectives of students, society, and the Ontario government. The backdrop for the investment analysis for society and the Ontario government is the entire province.

3.1 Student perspective

Analyzing the benefits and costs of education from the perspective of students is the most obvious—they give up time and money to go to college in return for a lifetime of higher earnings. The cost component of the analysis thus comprises the monies students pay (in the form of tuition and fees and forgone time and money), and the benefit component focuses on the extent to which the students' earnings increase as a result of their education.

3.1.1 Calculating student costs

Student costs consist of two main items: direct outlays and opportunity costs. Direct outlays include tuition and fees, equal to $89.3 million. We then subtract any grants and scholarships received by students. Direct outlays also include the cost of books and supplies. On average, full-time students spent $1,200 each on books and supplies during the reporting year.[9] Multiplying this figure times the number of full-time equivalents (FTEs) produced by Algonquin in FY 2012-13 (see Table 1.4) generates a total cost of $24.5 million for books and supplies.

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

We derive the students' full earning potential by weighting the average annual earnings in Table 1.7 according to the education level breakdown of the student population at the start of the analysis year.[10] The earnings in Table 1.7 reflect the midpoint of the average worker's career, however, not

[9] See Roslyn Kunin and Associates, "Economic Impact of International Education in Canada - An Update," Report presented to the Department of Foreign Affairs and International Trade, revised May 2012.

[10] To estimate the students' education level at the start of the analysis year, we first determine their education level at the end of the year (depending on the credentials they pursued), and then we move them backwards on the education ladder depending on their average course load.

his or her earnings while attending college. Because of this, we adjust the earnings to the average age of the student population (25) to better reflect their earnings at their current age.[11] This calculation yields an average full earning potential of $18,870 per student.

In determining what students earn while attending college, an important factor to consider is the time that they actually spend at college, since this is the only time that they are required to give up a portion of their earnings. We use the students' FTE production as a proxy for time, under the assumption that the more FTEs students earn, the less time they have to work, and, consequently, the greater their forgone earnings. Overall, Algonquin students earned an average of 0.89 FTEs per student, which is equal to 88.6% of a full academic year. We thus include no more than $14,078 (or 88.6%) of the students' full earning potential in the opportunity cost calculations.

Another factor to consider is the students' employment status while attending college. Algonquin estimates that their students work an average of 9.00 hours per week while attending their college. We assume students are either seeking work or planning to seek work once they complete their educational goals (with the exception of personal enrichment students, who are not included in this calculation). By choosing to go to college, non-working students give up everything that they can potentially earn during the academic year (*i.e.*, the $14,078). The total value of their forgone earnings thus comes to $251.9 million.

Working students are able to maintain all or part of their earnings while enrolled. However, many of them hold jobs that pay less than statistical averages, usually because those are the only jobs they can find that accommodate their course schedule. To account for this, we assume that working students hold jobs that pay 69% of what they would have earned had they chosen to work full-time rather than go to college.[12] The remaining 31% comprises the percent of their full earning potential that they forgo. Obviously this assumption varies by person—some students forego more and others less. Without knowing the actual jobs that students hold while attending, however, the 31% in forgone earnings serves as a reasonable average.

Working students also give up a portion of their leisure time in order to go to school, and mainstream theory places a value on this.[13] The amount of leisure time that students forgo is

---

[11] We use the lifecycle earnings function identified by Jacob Mincer to scale the earnings levels to the students' current age. See Jacob Mincer, "Investment in Human Capital and Personal Income Distribution," *Journal of Political Economy* 66, no. 4 (August 1958): 281–302. Further discussion on the Mincer function and its role in calculating the students' return on investment appears later in this chapter and in Appendix 4.

[12] The 69% assumption is based on the difference in earnings between individuals in school and individuals not in school with a full-time job. See Statistics Canada, "Table 7: Average income by highest level of education attained, school/work status and gender," Statistics Canada Youth in Transition Survey, last modified July 2009, accessed June 2013, http://www.statcan.gc.ca/pub/81-595-m/2009075/tbl/tbl7-eng.htm.

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

approximately 1.9 hours per day.[14] Assuming that an hour of leisure is equal in value to an hour of work, we derive the total cost of leisure by multiplying the number of leisure hours foregone during the academic year by the average hourly pay of the students' full earning potential. For working students, therefore, their total opportunity cost comes to $40.3 million, equal to the sum of their foregone earnings ($22.6 million) and forgone leisure time ($17.7 million).

Finally, the amount the students will pay for loan interest is considered as an opportunity cost since it represents the amount the students have to pay to borrow money. It was estimated that on average students will pay back their student loans in approximately 10 years. The amount of interest to be paid back by students was therefore calculated by assuming a 10-year repayment plan with a 4% interest rate for provincial student loans and 5.5% interest rate for federal student loans.[15] The total interest paid by students is $13.1 million, equal to the sum of provincial student loan interest ($4.3 million) and federal student loan interest ($8.8 million).

The steps leading up to the calculation of student costs appear in Table 3.1. Direct outlays amount to $84.3 million, the sum of tuition and fees ($89.3 million) and books and supplies ($24.5 million), less $28.5 million in grants and scholarships received by students and $1.0 million in direct outlays for personal enrichment students (these students are excluded from the cost calculations). Opportunity costs for all students amount to $305.4 million. Summing all values together yields a total of $389.7 million in student costs.

[14] Equal to the difference between the average number of leisure hours per day for students and the average number of leisure hours per day for non-students. See Human Resources and Skills Development Canada, "Leisure - Total Leisure Time," HRSDC Indicators of Well-being in Canada, accessed June 2013, http://www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=52 and Bureau of Labor Statistics, "Charts by Topic: Leisure and sports activities," BLS American Time Use Survey, last modified November 2012, accessed July 2013, http://www.bls.gov/TUS/CHARTS/LEISURE.HTM.

[15] Information on student loan repayment was obtained from the Ontario Ministry of Training, Colleges, and Universities (https://osap.gov.on.ca/AidEstimatorWeb/enterapp/debt_calculator.xhtml?lang=en).

Table 3.1: Algonquin student costs (thousands), 2012-13

Direct outlays	
Tuition and fees	$89,309
Books and supplies	$24,547
Less college funded scholarships	-$4,778
Less donor funded scholarships	-$925
Less provincial in-year grants	-$743
Less 30% off Ontario tuition	-$3,595
Less Ontario Student Opportunity Grant	-$9,098
Less federal in-year grants	-$9,410
Less direct outlays personal enrichment students	-$1,002
Total direct outlays	**$84,306**
Opportunity costs	
Earnings forgone by non-working students	$251,892
Earnings forgone by working students	$22,628
Value of leisure time forgone by working students	$17,710
Provincial student loan interest	$4,330
Federal student loan interest	$8,805
Total opportunity costs	**$305,365**
Total student costs	**$389,671**

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

3.1.2 Linking education to earnings

Having estimated the costs of education to students, we weigh these costs against the benefits that students receive in return. The relationship between education and earnings is well documented and forms the basis for determining student benefits. As shown in Table 1.7, mean earnings levels at the midpoint of the average-aged worker's career increase as people achieve higher levels of education. The differences in earnings define the upper bound benefits of moving from one education level to the next.[16]

A key component in determining the students' return on investment is the value of their future benefits stream, *i.e.*, what they can expect to earn in return for the investment they make in education. We calculate the future benefits stream to Algonquin's 2012-13 students first by determining their average annual increase in earnings, equal to $130.3 million. This value represents the higher earnings that accrue to students at the midpoint of their careers and is calculated based on the marginal wage increases of the credits that students complete while attending college. For a full description of the methodology used to derive the $130.3 million, see Appendix 4.

The second step is to project the $130.3 million annual increase in earnings into the future, for as long as students remain in the workforce. We do this by applying a set of scalars derived from the

[16] As discussed in Appendix 4, the upper bound benefits of education must be controlled for participant characteristics that also correlate with future wage increases, including inherent ability, socioeconomic status, and family background.

slope of the earnings function developed by Jacob Mincer to predict the change in earnings at each age in an individual's working career.[17] Appendix 4 provides more information on the Mincer function and how it is used to predict future earnings growth. With the $130.3 million representing the students' higher earnings at the midpoint of their careers, we apply scalars from the Mincer function to yield a stream of projected future benefits that gradually increase from the time students enter the workforce, come to a peak shortly after the career midpoint, and then dampen slightly as students approach retirement at age 65. This earnings stream appears in Column 2 of Table 3.2.

Table 3.2: Projected benefits and costs, student perspective

1	2	3	4	5	6
Year	Gross added earnings (millions)	Less adjustments (millions)*	Net added earnings (millions)	Costs (millions)	Net cash flow (millions)
0	$80.6	29%	$22.0	$389.7	-$367.7
1	$83.9	45%	$35.4	$0.0	$35.4
2	$87.1	52%	$42.8	$0.0	$42.8
3	$90.3	62%	$53.3	$0.0	$53.3
4	$93.4	77%	$67.9	$0.0	$67.9
5	$96.5	94%	$85.7	$0.0	$85.7
6	$99.6	94%	$88.6	$0.0	$88.6
7	$102.6	94%	$91.4	$0.0	$91.4
8	$105.5	94%	$94.2	$0.0	$94.2
9	$108.3	94%	$96.8	$0.0	$96.8
10	$111.0	94%	$99.4	$0.0	$99.4
11	$113.6	94%	$101.8	$0.0	$101.8
12	$116.1	94%	$104.0	$0.0	$104.0
13	$118.4	94%	$106.2	$0.0	$106.2
14	$120.6	94%	$108.1	$0.0	$108.1
15	$122.7	94%	$109.9	$0.0	$109.9
16	$124.6	94%	$111.6	$0.0	$111.6
17	$126.3	94%	$113.0	$0.0	$113.0
18	$127.9	94%	$114.3	$0.0	$114.3
19	$129.3	94%	$115.4	$0.0	$115.4
20	$130.5	94%	$116.3	$0.0	$116.3
21	$131.5	94%	$117.0	$0.0	$117.0
22	$132.4	94%	$117.5	$0.0	$117.5
23	$133.0	93%	$117.7	$0.0	$117.7
24	$133.5	93%	$117.8	$0.0	$117.8
25	$133.7	93%	$117.7	$0.0	$117.7
26	$133.7	92%	$117.3	$0.0	$117.3
27	$133.6	92%	$116.8	$0.0	$116.8
28	$133.2	92%	$116.0	$0.0	$116.0

[17] See Mincer, 1958.

Table 3.2: Projected benefits and costs, student perspective

1	2	3	4	5	6
Year	Gross added earnings (millions)	Less adjustments (millions)*	Net added earnings (millions)	Costs (millions)	Net cash flow (millions)
29	$132.7	75%	$94.0	$0.0	$94.0
30	$131.9	60%	$74.9	$0.0	$74.9
31	$131.0	47%	$58.5	$0.0	$58.5
32	$129.8	36%	$44.4	$0.0	$44.4
33	$128.5	27%	$32.5	$0.0	$32.5
34	$127.0	19%	$22.8	$0.0	$22.8
35	$125.3	13%	$15.2	$0.0	$15.2
36	$123.5	8%	$9.5	$0.0	$9.5
37	$121.5	5%	$5.5	$0.0	$5.5
38	$119.4	3%	$2.9	$0.0	$2.9
39	$117.1	1%	$1.4	$0.0	$1.4
Present value of cash flows			**$1,743.3**	**$389.7**	**$1,353.6**
Benefit-cost ratio					**4.5**
Return on investment (ROI)					**3.5**
Internal rate of return					**19.5%**
Payback period (no. of years)					**6.9**

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

Source: EMSI college impact model.

The final step in calculating the students' future benefits stream is to net out the income taxes students will pay annually over time, as well as any potential benefits generated by students who are either not yet active in the workforce or who leave the workforce over time. This adjustment appears in Column 3 of Table 3.2 and represents the percentage of the total 2012-13 student population that will be employed in the workforce in a given year. Note that the percentages in the first five years of the time horizon are relatively lower than those in subsequent years. This is because many students delay their entry into the workforce, either because they are still enrolled at the college or because they are unable to find a job immediately upon graduation. Accordingly, we apply a set of "settling-in" factors to account for the time needed by students to find employment and settle into their careers. As discussed in Chapter 2, settling-in factors delay the onset of the benefits by one to three years for students who graduate with a certificate or diploma, and by one to five years for continuing students. We apply no settling-in factors to the benefits for workforce students because the majority of them are employed while attending.

Beyond the first five years of the time horizon, students will leave the workforce over time for any number of reasons, whether because of death, retirement, or unemployment. We estimate the rate of attrition using the same data and assumptions applied in the calculation of the attrition rate in the economic impact analysis of Chapter 2. The likelihood that students leave the workforce increases as they age, so the attrition rate is more aggressive near the end of the time horizon than in the

beginning. Column 4 of Table 3.2 shows the net added earnings to students after accounting for both the settling-in patterns and attrition.

3.1.3 Return on investment to students

Having estimated the students' costs and their future benefits stream, the next step is to discount the results to the present to reflect the time value of money. For the student perspective we assume a discount rate of 3.75%[18] (see the "Discount Rate" box). The present value of the benefits is then compared to student costs to derive the investment analysis results, expressed in terms of a benefit-cost ratio, return on investment, rate of return, and payback period. The investment is feasible if returns match or exceed the minimum threshold values, *i.e.*, a benefit-cost ratio greater than 1, a return on investment greater than 0, a rate of return that exceeds the discount rate, and a reasonably short payback period.

Discount Rate

The discount rate is a rate of interest that converts future costs and benefits to present values. For example, $1,000 in higher earnings realized 30 years in the future is worth much less than $1,000 in the present. All future values must therefore be expressed in present value terms in order to compare them with investments (i.e., costs) made today. The selection of an appropriate discount rate, however, can become an arbitrary and controversial undertaking. As suggested in economic theory, the discount rate should reflect the investor's opportunity cost of capital, i.e., the rate of return one could reasonably expect to obtain from alternative investment schemes. In this study we assume a 3.75% discount rate from the student perspective and a 3.15% discount rate from the Ontario government perspective. The discount rate from the Ontario government perspective is lower because governments are large and can therefore spread their risks over a larger and more diverse investment portfolio than the private sector.

In Table 3.2, the higher earnings of Algonquin students are projected across their working lives by applying the Mincer curve, adjusted to account for students who are not active in the workforce and for income taxes they will pay over time, and discounted to the present. This yields a cumulative sum of approximately $1.7 billion, the present value of all of the future earnings increments (see Column 4 of Table 3.2). This may also be interpreted as the gross capital asset value of the students' higher earnings stream. In effect, the aggregate 2012-13 student body is rewarded for their investment in Algonquin with a capital asset valued at $1.7 billion.

The students' cost of attending Algonquin is shown in Column 5 of Table 3.2, equal to a present value of $389.7 million. Note that costs only occur in the single analysis year and are thus already in

[18] We use student loan rates to approximate the students' discount rate. Floating interest rates for Canada student loans are 2.5% plus the prime rate. See Government of Canada, "Interest Rates for Canada Student Loans," Student Loans & Grants. The prime rate – equal to 1.25% - is drawn from Bank of Canada, "Canadian interest rates and monetary policy variables: 10-year lookup," Bank of Canada Rates & Statistics. We thus have a student discount rate of 2.5% + 1.25% = 3.75%.

current year dollars. Comparing the cost with the present value of benefits yields a student benefit-cost ratio of 4.5 (equal to $1.7 billion in benefits divided by $389.7 million in costs).

The return on investment – or frequently referred to as "ROI" – is similar to the benefit-cost ratio except that the numerator used in the calculation is the net present value of the benefits, as opposed to the present value. This removes the cost of the investment from the numerator in order to derive the net return, *i.e.*, the amount that investors receive over and above each dollar of their original investment. ROI can also be derived simply by subtracting 1 from the benefit-cost ratio. A positive ROI means that the investment is profitable. In the case of Algonquin students, an ROI of 3.5 means that the students receive an additional $3.50 in present value terms for every dollar they invest in the college.

Another way to compare the same benefits stream and associated cost is to compute the internal rate of return. The internal rate of return indicates the interest rate that a bank would have to pay a depositor to yield an equally attractive stream of future payments.[19] Table 3.2 shows Algonquin students earning average returns of 19.5% on their investment of time and money. This is a favourable return compared, for example, to approximately 1% on a standard bank savings account, or 7% on stocks and bonds (thirty-year average return).

Note that returns reported in this study are real returns, not nominal. When a bank promises to pay a certain rate of interest on a savings account, it employs an implicitly nominal rate. Bonds operate in a similar manner. If it turns out that the inflation rate is higher than the stated rate of return, then money is lost in real terms. In contrast, a real rate of return is on top of inflation. For example, if inflation is running at 3% and a nominal percentage of 5% is paid, then the real rate of return on the investment is only 2%. In Table 3.2, the 19.5% student rate of return is a real rate. With an inflation rate of 1.9% (the average rate reported over the past 20 years as per the Statistics Canada, Consumer Price Index), the corresponding nominal rate of return is 21.3%, higher than what is reported in Table 3.2.

The payback period is defined as the length of time it takes to entirely recoup the initial investment.[20] Beyond that point, returns are what economists would call "pure costless rent." As

---

[19] Note that, with a bank deposit or stock market investment, the depositor puts up a principal, receives in return a stream of periodic payments, and then recovers the principal at the end. An education investor, on the other hand, receives a stream of periodic payments that include the recovery of the principal as part of the periodic payments, but there is no principal recovery at the end. These differences notwithstanding, comparable cash flows for both bank and education investors yield the same internal rate of return.

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

indicated in Table 3.2, students at Algonquin see, on average, a payback period of 6.9 years on their forgone earnings and out-of-pocket costs.

3.2 Social perspective

Society as a whole in Ontario benefits from the education that Algonquin provides through the income that students create in the province and through the savings that they generate through their improved lifestyles. To receive these benefits, however, members of society must pay money and forgo services that they would have otherwise enjoyed if Algonquin did not exist. Society's investment in Algonquin stretches across a number of investor groups, from students to employers to the Ontario government. From the social perspective, therefore, we weigh the benefits generated by Algonquin to society against all funding received by the college and used in its operating budget, equal to $264.4 million (see Table 1.3). This comprises the cost component of the analysis.

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

Beekeeper Analogy

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

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

Educational institutions are like beekeepers. While their principal aim is to provide education and raise people's earnings, in the process an array of external benefits are created. Students' health and lifestyles are improved, and society indirectly benefits just as orchard owners indirectly benefit from beekeepers. Aiming at a more complete accounting of the benefits of provincial government expenditures and other outside funding on education, the college impact model tracks and accounts for many of these external social benefits.

It is important to note that by comparing benefits to society against costs to the Ontario government, we are including more benefits than a standard investment analysis typically allows. As such, most of the standard measures used in investment analysis (*i.e.*, the net present value, return on

investment, rate of return, and payback period) no longer apply. Under the social perspective, we only present the benefit-cost ratio, recognizing that the benefits component accrues to a lot more people than just the Ontario government and other funders. Therefore, because of this, the results calculated on the basis of those benefits should be viewed strictly as a comparison between public benefits and costs to those providing funding to the college.

3.2.1 Income growth in the province

In the process of absorbing the newly-acquired skills of Algonquin students, not only does the productivity of Ontario's workforce increase, but so does the productivity of its physical capital and assorted infrastructure. Students earn more because of the skills they learned while attending college, and businesses earn more because student skills make capital more productive (*i.e.*, buildings, machinery, and everything else). This in turn raises profits and other business property income. Together, increases in earnings and other provincial income are considered the effect of a skilled workforce.

Estimating the effect of Algonquin on income growth in the province begins with the present value of the students' future earnings stream, which is displayed in Column 4 of Table 3.2. To this we apply a multiplier derived from EMSI's CRIO model to estimate the additional earnings created in the province as students and businesses spend their higher earnings.[21] As earnings increase, so do other forms of income in the province, including monies gained through investments. To calculate the growth in other income, we multiply the increase in earnings by a ratio of Ontario's Gross Domestic Product to total earnings in the province.

The sum of the students' higher earnings, multiplier effects, and increases in other income comprises the gross added income that accrues to society as a whole in the province. Not all of this income may be counted as benefits to the province, however. Some students leave the province during the course of their careers, and the higher earnings they receive as a result of their education leaves the province with them. To account for this dynamic, we combine student settlement data from Algonquin with data on migration patterns from Statistics Canada to estimate the number of students who will leave the provincial workforce over time.

We apply another reduction factor to account for the students' alternative education opportunities. This is the same adjustment that we use in the calculation of the past students' productivity effect in Chapter 2 and is designed to account for the counterfactual scenario where Algonquin does not exist. The assumption in this case is that any benefits generated by students who could have received an education even without Algonquin cannot be counted as new benefits to society.[22] For this

[21] For a full description of the CRIO model, see Appendix 3.

[22] A situation in which there were no public institutions in the province is virtually impossible. The adjustment is entirely hypothetical and is used merely to examine Algonquin in standard investment analysis terms by accounting for benefits that would have occurred anyway, even if the college did not exist.

analysis, we estimate an alternative education variable of 23%, meaning that 23% of the student population at Algonquin would have generated benefits anyway even without the college. For more information on the calculation of the alternative education variable, see Appendix 5.

Another adjustment – the "shutdown point" – nets out benefits that are not directly linked to the provincial government costs of supporting the college. As with the alternative education variable, the purpose of this adjustment is to account for counterfactual scenarios, in this case, the situation where provincial government funding for Algonquin does not exist. To estimate the shutdown point, we apply a sub-model that simulates the students' demand curve for education by reducing provincial government support to zero and progressively increasing student tuition and fees. As student tuition and fees increase, enrollment declines. For Algonquin, the shutdown point adjustment is 0%, meaning that Algonquin could not operate without provincial government support. As such, no reduction applies. For more information on the theory and methodology behind the estimation of the shutdown point, see Appendix 7.

After adjusting for attrition, alternative education opportunities, and the shutdown point, we calculate the present value of the future added income that occurs in the province, equal to $5.6 billion (this value appears again later in this chapter in Table 3.3). Recall from the discussion of the student return on investment that the present value represents the sum of the future benefits that accrue each year over the course of the time horizon, discounted to current year dollars to account for the time value of money. The discount rate in this case is 3.15%, the real treasury interest rate recommended by the Bank of Canada for long-term investments.[23]

3.2.2 Social savings

In addition to the creation of higher income in the province, education is statistically associated with a variety of lifestyle changes that generate social savings, also known as external or incidental benefits of education. These represent the avoided costs that would have otherwise been drawn from private and public resources absent the education provided by Algonquin. Social benefits appear in Table 3.5 and break down into three main categories: 1) health savings, 2) crime savings, and 3) income assistance savings. Health savings include avoided medical costs, lost productivity, and other effects associated with smoking, alcoholism, obesity, and mental illness. Crime savings consist of avoided costs to the justice system (*i.e.*, police protection, judicial and legal, and corrections), avoided victim costs, and benefits stemming from the added productivity of individuals who would have otherwise been incarcerated. Income assistance savings comprise avoided costs due to the reduced number of claims for employment insurance and other forms of employment-related social assistance.

[23] Bank of Canada, "Government of Canada benchmark bond yields - long-term," Bank of Canada Selected Bond Yields, accessed October 2013, http://www.bankofcanada.ca/rates/interest-rates/canadian-bonds/.

The model quantifies the social savings by calculating the probability at each education level that individuals will have poor health, commit crimes, or claim income assistance. Deriving the probabilities involves assembling data from a variety of studies and surveys analyzing the correlation between education and health, crime, and income assistance at the national and provincial level. We spread the probabilities across the education ladder and multiply the marginal differences by the number of students who achieved credits at each step. The sum of these marginal differences counts as the upper bound measure of the number of students who, due to the education they received at Algonquin, will not have poor health, commit crimes, or claim income assistance. We dampen these results by the "ability bias" adjustment discussed earlier in this chapter and in Appendix 4 to account for other factors besides education that influence individual behaviour. We then multiply the marginal effects of education times the associated costs of health, crime, and income assistance.[24] Finally, we apply the same adjustments for attrition, alternative education, and the shutdown point to derive the net savings to society.

Table 3.3: Present value of the future added income and social savings in the province (thousands)

Added Income	**$5,584,385**
Social Savings	
Health	
Smoking	$24,055
Alcoholism	$5,869
Obesity	$4,570
Mental illness	$5,074
Total health savings	**$39,567**
Crime	
Criminal Justice System savings	$410
Crime victim savings	$792
Added productivity	$185
Total crime savings	**$1,387**
Income assistance	
Employment insurance savings	$2,575
Employment-related social assistance savings	$1,455
Total income assistance savings	**$4,030**
Total social savings	**$44,984**
Total, added income + social savings	**$5,629,369**

Source: EMSI college impact model.

Table 3.3 above displays the results of the analysis. The first row shows the added income created in the province, equal to $5.6 billion. Social savings appear next, beginning with a breakdown of savings related to health. These savings amount to a present value of $39.6 million, including savings due to a reduced demand for medical treatment and social services, improved worker productivity

[24] For a full list of the data sources used to calculate the social externalities, see Appendix 1. See also Appendix 8 for a more in-depth description of the methodology.

and reduced absenteeism, and a reduced number of vehicle crashes and fires induced by alcohol or smoking-related incidents. Crime savings sum to $1.4 million, including savings associated with a reduced number of crime victims, added worker productivity, and reduced expenditures for police and law enforcement, courts and administration of justice, and corrective services. Finally, the present value of the savings related to income assistance amount to $4.0 million, stemming from a reduced number of persons in need of employment insurance and employment-related social assistance. All told, social savings amounted to $45.0 million in benefits to society as a whole in Ontario.

The sum of the social savings and the added income in the province is $5.6 billion, as shown in the bottom row of Table 3.3. These savings accrue for years out into the future, for as long as Algonquin's 2012-13 students remain in the workforce.

3.2.3 Benefit-cost ratio to society

The $5.6 billion in present value benefits re-appears at the bottom of Column 2 in Table 3.4. Society funding support of Algonquin and spent by the college is listed in the next column, equal to $264.4 million. Note that, unlike streams of benefits that go on into the future, the amount the college spent of $264.4 million was made in the single reporting year. Its present value and nominal dollar value are thus the same.

Table 3.4: Projected benefits and costs, social perspective

1	2	3	4
Year	Benefits to society (millions)	Provincial gov't costs (millions)	Net cash flow (millions)
0	$70.1	$264.4	-$194.4
1	$107.8	$0.0	$107.8
2	$130.1	$0.0	$130.1
3	$161.6	$0.0	$161.6
4	$205.6	$0.0	$205.6
5	$258.7	$0.0	$258.7
6	$266.7	$0.0	$266.7
7	$274.5	$0.0	$274.5
8	$281.9	$0.0	$281.9
9	$289.1	$0.0	$289.1
10	$295.9	$0.0	$295.9
11	$302.3	$0.0	$302.3
12	$308.3	$0.0	$308.3
13	$313.9	$0.0	$313.9
14	$319.1	$0.0	$319.1
15	$323.8	$0.0	$323.8
16	$328.0	$0.0	$328.0
17	$331.8	$0.0	$331.8
18	$335.0	$0.0	$335.0

Table 3.4: Projected benefits and costs, social perspective

1	2	3	4
Year	Benefits to society (millions)	Provincial gov't costs (millions)	Net cash flow (millions)
19	$337.7	$0.0	$337.7
20	$339.8	$0.0	$339.8
21	$341.4	$0.0	$341.4
22	$342.5	$0.0	$342.5
23	$343.0	$0.0	$343.0
24	$342.9	$0.0	$342.9
25	$342.3	$0.0	$342.3
26	$341.1	$0.0	$341.1
27	$339.3	$0.0	$339.3
28	$336.9	$0.0	$336.9
29	$272.8	$0.0	$272.8
30	$217.5	$0.0	$217.5
31	$169.8	$0.0	$169.8
32	$128.9	$0.0	$128.9
33	$94.4	$0.0	$94.4
34	$66.3	$0.0	$66.3
35	$44.2	$0.0	$44.2
36	$27.7	$0.0	$27.7
37	$16.1	$0.0	$16.1
38	$8.6	$0.0	$8.6
39	$4.1	$0.0	$4.1
Net present value	**$5,629.4**	**$264.4**	**$5,364.9**
Benefit-cost ratio			**21.3**

Source: EMSI college impact model.

Having now defined the present values of costs and benefits, the model forms a benefit-cost ratio of roughly 21.3 (= $5.6 billion worth of benefits ÷ $264.4 million worth of college expenditures). Recall that this ratio reflects the measure of all benefits generated regardless of to whom they accrue. Students are the beneficiaries of higher earnings, employers are beneficiaries of lower absenteeism and increased worker productivity, still others are beneficiaries of improved health, and so on. These are widely-dispersed benefits that do not necessarily return to those funding the colleges' expenditures, who pay costs at full measure. Inasmuch as investors and beneficiaries are not the same individuals, measures common to standard investment analyses such as return on investment, internal rate of return, and payback period no longer apply. From the social perspective, therefore, the benefit-cost ratio should be viewed strictly as a comparison between public benefits and funding support costs.

3.3 Ontario government perspective

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

3.3.1 Benefits to the Ontario government

Table 3.5 displays the present value of the benefits to the Ontario government. Added tax revenue appears in the first row. These figures are derived by multiplying the income growth figures from Table 3.3 by the prevailing provincial government tax rates in Ontario. For the social externalities, we claim only the benefits that reduce the demand for government-supported social services, or the government benefits resulting from improved productivity among government employees. The present value of future tax revenues and government savings thus comes to approximately $907.3 million.

Table 3.5: Present value of added tax revenue and government savings (thousands)

Added tax revenue	**$889,167**
Government savings	
Health-related savings	$13,656
Crime-related savings	$448
Income assistance savings	$4,030
Total government savings	**$18,134**
Total provincial government benefits	**$907,301**

Source: EMSI college impact model.

3.3.2 Return on investment

Provincial government costs are reported in Table 3.6 and come to $147.3 million, equal to the annual contribution of provincial government to Algonquin, including provincial grants and the capital costs of provincial loans. In return for its public support, therefore, the Ontario government is rewarded with an investment benefit-cost ratio of 6.2 (= $907.3 million ÷ $147.3 million). The return on investment is 5.2, indicating a profitable investment.

Table 3.6: Projected benefits and costs, Ontario government perspective

1 Year	2 Benefits to the provincial gov't (millions)	3 Provincial gov't costs (millions)	4 Net cash flow (millions)
0	$11.3	$147.3	-$136.0
1	$17.4	$0.0	$17.4
2	$21.0	$0.0	$21.0
3	$26.1	$0.0	$26.1
4	$33.2	$0.0	$33.2
5	$41.7	$0.0	$41.7
6	$43.0	$0.0	$43.0
7	$44.3	$0.0	$44.3
8	$45.5	$0.0	$45.5
9	$46.6	$0.0	$46.6
10	$47.7	$0.0	$47.7
11	$48.7	$0.0	$48.7
12	$49.7	$0.0	$49.7
13	$50.6	$0.0	$50.6
14	$51.4	$0.0	$51.4
15	$52.2	$0.0	$52.2
16	$52.8	$0.0	$52.8
17	$53.4	$0.0	$53.4
18	$54.0	$0.0	$54.0
19	$54.4	$0.0	$54.4
20	$54.7	$0.0	$54.7
21	$55.0	$0.0	$55.0
22	$55.2	$0.0	$55.2
23	$55.2	$0.0	$55.2
24	$55.2	$0.0	$55.2
25	$55.1	$0.0	$55.1
26	$54.9	$0.0	$54.9
27	$54.7	$0.0	$54.7
28	$54.3	$0.0	$54.3
29	$43.9	$0.0	$43.9
30	$35.0	$0.0	$35.0
31	$27.3	$0.0	$27.3
32	$20.8	$0.0	$20.8
33	$15.2	$0.0	$15.2
34	$10.7	$0.0	$10.7
35	$7.1	$0.0	$7.1
36	$4.5	$0.0	$4.5
37	$2.6	$0.0	$2.6
38	$1.4	$0.0	$1.4
39	$0.7	$0.0	$0.7
Net present value	**$907.3**	**$147.3**	**$760.0**

Table 3.6: Projected benefits and costs, Ontario government perspective

1 Year	2 Benefits to the provincial gov't (millions)	3 Provincial gov't costs (millions)	4 Net cash flow (millions)
Benefit-cost ratio			**6.2**
Return on investment (ROI)			**5.2**
Internal rate of return			**24.1%**
Payback period (no. of years)			**5.9**

Source: EMSI college impact model.

At 24.1%, the rate of return to the Ontario government is also favourable. As above, we assume a 3.15% discount rate when dealing with government investments and public finance issues. This is the return governments are assumed to be able to earn on generally safe investments of unused funds, or alternatively, the interest rate for which governments, as relatively safe borrowers, can obtain funds. A rate of return of 3.15% would mean that the college just pays its own way. In principle, governments could borrow monies used to support Algonquin and repay the loans out of the resulting added taxes and reduced government expenditures. A rate of return of 24.1%, on the other hand, means that Algonquin not only pays its own way, but it also generates a surplus that provincial government can use to fund other programs. It is unlikely that other government programs could make such a claim.

3.3.3 With and without social savings

Earlier in this chapter, social benefits attributable to education (reduced crime, fewer income assistance claims, and improved health) were defined as externalities that are incidental to the operations of the college. Some would question the legitimacy of including these benefits in the calculation of rates of return to education, arguing that only the tangible benefits, *i.e.*, higher income, should be counted. Tables 3.4 and 3.6 are inclusive of social benefits reported as attributable to Algonquin. Recognizing the other point of view, Table 3.7 shows the results for both the social and Ontario government perspectives exclusive of social benefits. As indicated, returns are still above threshold values (a benefit-cost ratio greater than 1.0, a return on investment greater than 0, and a rate of return greater than 3.15%), confirming that society and the Ontario government receive value from investing in Algonquin.

Table 3.7: Social and Ontario government perspectives with and without social savings

	Including social savings (thousands)	Excluding social savings (thousands)
Social perspective		
Net present value	$5,364,931	$5,319,947
Benefit-cost ratio	21.3	21.1
Ontario government perspective		
Net present value	$759,971	$741,644
Benefit-cost ratio	6.2	6.0
Return on investment	5.2	5.0
Internal rate of return	24.1%	23.6%
Payback period (no. of years)	5.9	6.0

Source: EMSI college impact model.

3.4 Conclusion

This chapter has shown that Algonquin is an attractive investment to its major stakeholders – students, society, and the Ontario government. Rates of return to students invariably exceed alternative investment opportunities. At the same time, provincial government can take comfort in knowing that its expenditure of funds creates a wide range of positive social benefits and, perhaps more importantly, actually returns more to government budgets than it costs. Without these increased tax receipts and public sector savings provided by the educational activities of Algonquin and its students, provincial government would have to raise taxes to make up for lost revenues and added costs.

Chapter 4: Sensitivity Analysis

Sensitivity analysis is the process by which researchers determine how sensitive the outputs of the model are to variations in the background data and assumptions, especially if there is any uncertainty in the variables. Sensitivity analysis is also useful for identifying a plausible range wherein the results will fall should any of the variables deviate from expectations. In this chapter we test the sensitivity of the model to the following input factors: 1) government funding, 2) Ontario's tax environment, 3) the alternative education variable, 4) the substitution effect variable, 5) the student employment variables, and 6) the discount rate.

4.1 Ontario government funding

In the Ontario government investment analysis we treat all Ontario government funding, $147.3 million, as the cost of generating the government's benefits. Spreading the government funding across all FTEs yields $7,084 per FTE. To illustrate the sensitivity of the various investment measures to the level of government funding, we simulate variations of plus or minus 10%, 25%, and 50% of the base level of government funding per FTE. Table 4.1 illustrates the results. The base case is presented in the middle column, with cases using plus or minus 10%, 25%, and 50% variation on either side. Analyses are then redone introducing one change at a time, holding all other variables constant. For example, an increase of 10% in the funding per FTE (from $7,084 to $7,792) reduces the Ontario government perspective benefit-cost ratio from 6.2 to 5.6. Likewise, a decrease of 10% (from $7,084 to $6,375) in the funding per FTE increases the benefit-cost ratio from 6.2 to 6.8.

Table 4.1: Sensitivity analysis of Ontario government funding

% variation in funding	-50%	-25%	-10%	Base Case	10%	25%	50%
Funding per FTE	$3,542	$5,313	$6,375	$7,084	$7,792	$8,855	$10,625
Net present value (millions)	$833.6	$796.8	$774.7	$760.0	$745.2	$723.1	$686.3
Benefit-cost ratio	12.3	8.2	6.8	6.2	5.6	4.9	4.1
Return on investment	43.9%	30.7%	26.3%	24.1%	22.2%	19.9%	17.0%
Rate of return	11.3	7.2	5.8	5.2	4.6	3.9	3.1

The Ontario government investment analysis is very sensitive to the level of government funding or government costs. The above sensitivity analysis effectively changes the costs while holding the benefits constant. We realize that in reality changing funding levels while holding everything else constant is not likely. These results are simply to illustrate the significance of the level of government funding in calculating the Ontario government investment measures.

4.2 Ontario's tax environment

The benefits to the Ontario government used in calculating the investment measures consist of increased tax payments and social savings. Table 3.7 illustrates the effect of the social savings on the

investment measures. In this section we demonstrate the effect of the additional tax payments on the Ontario government's investment analysis. The additional Ontario tax payments are determined by personal income tax rates, corporate tax rates, and various taxes on production. Rather than varying tax rates separately, we illustrate the effect of increasing or decreasing the overall effective tax rate by 10%, 25%, and 50% from the base rate. The results are presented in Table 4.2.

Table 4.2: Sensitivity analysis of Ontario's tax environment

% variation in tax rate	-50%	-25%	-10%	Base Case	10%	25%	50%
Effective tax rate	7.9%	11.9%	14.3%	15.9%	17.5%	19.9%	23.8%
Net present value (millions)	$315.4	$537.7	$671.1	$760.0	$848.9	$982.3	$1,204.6
Benefit-cost ratio	3.1	4.6	5.6	6.2	6.8	7.7	9.2
Return on investment	13.5%	19.0%	22.0%	24.1%	26.0%	28.9%	33.8%
Rate of return	2.1	3.6	4.6	5.2	5.8	6.7	8.2

As taxes increase, the benefits accruing to the Ontario government increase, and the investment measures improve. Likewise, as the tax rates decrease, the benefits to the Ontario government decrease and the investment measures become poorer. Given that tax rates largely determine the benefits to the Ontario government, it should be no surprise that the Ontario government investment analysis is relatively sensitive to changes in the tax environment.

4.3 Alternative education variable

The alternative education variable (23%) accounts for the counterfactual scenario where students would have to seek a similar education elsewhere absent the publicly-funded training providers in the province. Given the difficulty in accurately specifying the alternative education variable, we test the sensitivity of the provincial government 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 4.3.

Table 4.3: Sensitivity analysis of alternative education variable, Ontario government perspective

% variation in assumption	-50%	-25%	-10%	Base Case	10%	25%	50%
Alternative education variable	12%	18%	21%	23%	26%	29%	35%
Net present value (millions)	$898.5	$829.2	$787.7	$760.0	$732.3	$690.7	$621.5
Benefit-cost ratio	7.1	6.6	6.3	6.2	6.0	5.7	5.2
Return on investment	6.1	5.6	5.3	5.2	5.0	4.7	4.2
Rate of return	27.1%	25.6%	24.7%	24.1%	23.4%	22.5%	20.9%

Based on this sensitivity analysis, the conclusion can be drawn that Algonquin investment analysis results from the provincial government perspective are not very sensitive to relatively large variations in the alternative education variable. The conclusion is that although the assumption is difficult to specify, its impact on overall investment analysis results for the Ontario government perspective is not very sensitive.

4.4 Substitution effect variable

The substitution effect variable only affects the past students' productivity calculation in Table 2.5. In the model we assume a substitution effect variable of 50%, which means that we claim only 50% of the initial earnings generated by increased past students' productivity. The other 50% we assume would have been created in the region anyway – even without Algonquin – since the businesses that hired Algonquin students could have substituted some of these workers with equally-qualified people from outside the region had there been no Algonquin students to hire.

Table 4.4 presents the results of the sensitivity analysis for the substitution effect variable. As above, the assumption increases and decreases relative to the base case of 50% by the increments indicated in the table. Past students' productivity effects attributable to Algonquin, for example, range from a low of $1.1 billion at a -30% variation to a high of $2.1 billion at a +30% variation from the base case assumption. This means that if the substitution variable increases, the impact that we claim as attributable to past students' productivity increases as well. Nonetheless, the effect of past students' productivity still remains a sizeable factor in the Ottawa Region economy, even under the most conservative assumptions.

Table 4.4: Sensitivity analysis of substitution effect variable

% variation in assumption	-30%	-20%	-10%	Base Case	10%	20%	30%
Substitution effect variable	35%	40%	45%	50%	55%	60%	65%
Past students' productivity effect (millions)	$1,106.7	$1,264.8	$1,422.9	$1,581.0	$1,739.2	$1,897.3	$2,055.4

4.5 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 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 college. Both employment variables affect the investment analysis results from the student perspective.

Students incur substantial expense by attending Algonquin 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 23% of students who reported their employment status are employed, based on data provided by Algonquin. 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 college earn only 69%, on average, of the earnings that they would have statistically received if not attending Algonquin. This suggests that many students hold jobs that accommodate their Algonquin 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 this difference in wages and counts it as part of the opportunity cost of time. As above, the 69% estimate is tested in the sensitivity analysis by changing it to 100% and then to 0%.

The changes generate results summarized in Table 4.5, 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 23% and B equal to 69%. 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 4.5: Sensitivity analysis of student employment variables

Variations in assumptions	Net present value (millions)	Benefit-cost ratio	Return on investment	Internal rate of return
Base case: A = 23%, B = 69%	$1,353.6	4.5	3.5	19.5%
Scenario 1: A = 100%, B = 69%	$1,479.7	6.6	5.6	27.0%
Scenario 2: A = 23%, B = 100%	$1,389.4	4.9	3.9	21.1%
Scenario 3: A = 100%, B = 100%	$1,580.3	10.7	9.7	40.7%
Scenario 4: A = 0%, B = 0%	$1,333.9	4.3	3.3	18.7%

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

1. Scenario 1: Increasing the percent of students employed (A) from 23% to 100%, the net present value, benefit-cost ratio, return on investment, and internal rate of return improve to $1.5 billion, 6.6, 5.6, and 27.0%, respectively, relative to base case results. Improved results are attributable to a lower opportunity cost of time – all students are employed in this case.
2. Scenario 2: Increasing earnings relative to statistical averages (B) from 69% to 100%, the net present value, benefit-cost ratio, return on investment, and internal rate of return improve to $1.4 billion, 4.9, 3.9, and 21.1%, 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 net present value, benefit-cost ratio, return on investment, and internal rate of return improve yet further to $1.6 billion, 10.7, 9.7 and 40.7%, 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 net present value, benefit-cost ratio, return on investment, and internal rate of return to $1.3 billion, 4.3, 3.3, and 18.7%, respectively, relative to base case results. These results are reflective of an increased opportunity cost – none of the students are employed in this case.[25]

[25] 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.

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 Algonquin generate excellent returns, well above the long-term average percent rates of return in stock and bond markets.

4.6 Discount rate

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

In this study, we assume a 3.75% discount rate for students and a 3.15% discount rate for society and the Ontario government.[26] Similar to the sensitivity analysis of the alternative education variable, we vary the base case discount rates for students, society, and the Ontario government 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, benefit-cost ratio, and return on investment are shown for students, society, and the Ontario government in Table 4.6.

[26] These values are based student loan rates from the Government of Canada and benchmark yields for long-term bonds from the Bank of Canada. See the Government of Canada, Student Loans & Grants and the Bank of Canada, Selected Bond Yields.

Table 4.6: Sensitivity analysis of discount rate

% variation in assumption	-50%	-25%	-10%	Base Case	10%	25%	50%
Student perspective							
Discount rate	1.9%	2.8%	3.4%	3.75%	4.1%	4.7%	5.6%
Net present value (millions)	$1,927.8	$1,612.8	$1,451.4	$1,353.6	$1,262.9	$1,138.9	$960.0
Benefit-cost ratio	5.9	5.1	4.7	4.5	4.2	3.9	3.5
Return on investment	4.9	4.1	3.7	3.5	3.2	2.9	2.5
Social perspective							
Discount rate	1.6%	2.4%	2.8%	3.15%	3.5%	3.9%	4.7%
Net present value (millions)	$6,914.9	$6,075.8	$5,635.4	$5,364.9	$5,111.3	$4,759.9	$4,242.6
Benefit-cost ratio	27.1	24.0	22.3	21.3	20.3	19.0	17.0
Return on investment	26.1	23.0	21.3	20.3	19.3	18.0	16.0
Ontario government perspective							
Discount rate	1.6%	2.4%	2.8%	3.15%	3.5%	3.9%	4.7%
Net present value (millions)	$1,009.7	$874.5	$803.5	$760.0	$719.1	$662.5	$579.1
Benefit-cost ratio	7.9	6.9	6.5	6.2	5.9	5.5	4.9
Return on investment	6.9	5.9	5.5	5.2	4.9	4.5	3.9

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 3.75% to 5.6%) reduces the students' benefit-cost ratio from 4.5 to 3.5. Conversely, reducing the discount rate for students by 50% (from 3.75% to 1.9%) increases the benefit-cost ratio from 4.5 to 5.9. The sensitivity analysis results for society and the Ontario government 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 27.1 benefit-cost ratio at a -50% variation from the base case to a 17.0 benefit-cost ratio at a 50% variation from the base case).

Appendix 1: Resources and References

Adlaf, Edward, Patricia Begin, and Edward Sawka, eds. *Canadian Addiction Survey (CAS): A national survey of Canadians' use of alcohol and other drugs: Prevalence of use and related harms: Detailed report.* Ottawa: Canadian Centre on Substance Abuse, 2005.

Babooram, Avani. "The changing profile of adults in custody, 2006/2007." Statistics Canada, *Juristat* 28, no. 10 (December 2008). Accessed July 2013. http://www.statcan.gc.ca/pub/85-002-x/2008010/article/10732-eng.pdf.

Bank of Canada. "Canadian interest rates and monetary policy variables: 10-year lookup." Bank of Canada Rates & Statistics. Accessed October 2013. http://www.bankofcanada.ca/rates/interest-rates/canadian-interest-rates/.

Bank of Canada. "Government of Canada benchmark bond yields - long-term." Bank of Canada Selected Bond Yields. Accessed October 2013. http://www.bankofcanada.ca/rates/interest-rates/canadian-bonds/.

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

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

Bureau of Labor Statistics. "Time use on an average weekday for full-time university and college students" in "Charts by Topic: Students." BLS American Time Use Survey. Accessed June 2013. http://www.bls.gov/TUS/CHARTS/STUDENTS.HTM.

Canadian Automobile Association. "Driving Costs 2013." CAA, August 2013. Accessed October 2013. http://www.caa.ca/driving-costs/.

Canadian Institute for Health Information. "Figure 9: Total Health Expenditures by Source of Finance, 2010 (Billions of Dollars and Percentage Share)" in "National Health Expenditure Trends, 1975 to 2012." Ottawa, ON: CIHI, 2012.

Canada Revenue Agency. "Canadian income tax rates for Individuals - current and previous years." Accessed September 2013. http://www.cra-arc.gc.ca/tx/ndvdls/fq/txrts-eng.html.

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

Centre for Urban and Community Studies. "Table 1. Socio-demographic profile of analytic sample by activity restriction status and welfare status" in "The Health of Canadians on Welfare." Research Bulletin #24. Accessed October 2013.

http://www.urbancentre.utoronto.ca/pdfs/researchbulletins/CUCS_RB_24_Vozoris_Tarasu.pdf.

Dauvergne, Mia. "Adult correctional statistics in Canada, 2010/2011." Canadian Centre for Justice Statistics, *Juristat* article. Released October 11, 2012. Accessed July 2013. http://www.statcan.gc.ca/pub/85-002-x/2012001/article/11715-eng.pdf.

Desjardins, Louise and Darren King. "Expectations and Labour Market Outcomes of Doctoral Graduates from Canadian Universities." Statistics Canada, Human Resources and Skills Development Canada, Tourism and Centre for Education Statistics Division, January 2011. Accessed September 2013. http://www.statcan.gc.ca/pub/81-595-m/81-595-m2011089-eng.pdf.

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

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

Federal-Provincial-Territorial Directors of Income Support. Social Assistance Statistical Report, 2008. Gatineau, Quebec: FTP Directors of Income Support, September 2010. Accessed July 2013. http://www.wellington.ca/en/socialservices/resources/SocialAssistanceStatisticalReport2008.pdf.

Ferrer, Ana and Craig Riddell. "The role of credentials in the Canadian labour market." *Canadian Journal of Economics* 35, no. 4 (November 2002): 879-905.

Flegg, A.T. and C.D. Webber. "On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables." *Regional Studies* 29, no. 6 (1994): 547-561.

Flegg, A.T. and C.D. Webber. "On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables: Reply." *Regional Studies* 31, no. 8 (1997): 795-805.

Flegg, A.T. and T. Tohmo. "Regional Input-Output Tables and the FLQ Formula: A Case Study of Finland." *Regional Studies* 47, no. 5 (2013): 703-721.

Flegg, A.T. and C.D. Webber. "Regional Size, Industrial Location and Input-Output Expenditure Coefficients." *Regional Studies* 32, no. 55 (1997): 435-444.

Flegg, A.T. and C.D. Webber. "Regional Size, Regional Specialization and the FLQ Formula." *Regional Studies* 34, no. 6 (2000): 563-569.

Government of Canada. "Current and Forthcoming Minimum Hourly Wage Rates for Experienced Adult Workers in Canada." Government of Canada Minimum Wage Database. Last modified

July 2013. Accessed October 2013. http://srv116.services.gc.ca/dimt-wid/sm-mw/rpt1.aspx?lang=eng.

Government of Canada. "Deciding when to apply for your CPP retirement pension." Government of Canada Service Canada. Accessed June 2013. http://www.servicecanada.gc.ca/eng/isp/pub/factsheets/cppretirement/when.shtml.

Government of Canada. *The Human Face of Mental Health and Mental Illness in Canada 2006*. Minister of Public Works and Government Services Canada, 2006.

Government of Canada. "Interest Rates for Canada Student Loans." Student Loans & Grants. Last modified July 2013. Accessed October 2013. http://www.canlearn.ca/eng/loans_grants/repayment/interest.shtml.

Health Canada. "Figure 2: Current smokers by sex and education level" in "Men and Smoking in Canada." Health Canada Canadian Tobacco Use Monitoring Survey, Annual I February-December 2002. Accessed June 2013. http://www.hc-sc.gc.ca/hc-ps/alt_formats/hecs-sesc/pdf/tobac-tabac/research-recherche/stat/_ctums-esutc_fs-if/2002_men-hommes-eng.pdf.

Health Canada. "Table 2: Main 2011 CADUMS indicators by province-Drugs" in Canadian Alcohol and Drug Use Monitoring Survey. Health Canada Drug and Alcohol Use Statistics. Accessed June 2013. http://www.hc-sc.gc.ca/hc-ps/drugs-drogues/stat/_2011/tables-tableaux-eng.php#t2.

Health Canada. "Table 2. Smoking status and average number of cigarettes smoked per day, by province, age group and sex, age 15+ years, Canada 2011." Health Canada Canadian Tobacco Use Monitoring Survey (CTUMS) 2011. Accessed June 2013. http://www.hc-sc.gc.ca/hc-ps/tobac-tabac/research-recherche/stat/_ctums-esutc_2011/ann-eng.php#t8.

Health Canada. "Table 8. Smoking and education, age 15+ years, Canada 2011." Health Canada Canadian Tobacco Use Monitoring Survey (CTUMS) 2011. Accessed June 2013. http://www.hc-sc.gc.ca/hc-ps/tobac-tabac/research-recherche/stat/_ctums-esutc_2011/ann-eng.php#t8.

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

Human Resources and Skills Development Canada. "Leisure - Total Leisure Time." HRSDC Indicators of Well-being in Canada. Accessed June 2013. http://www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=52.

Human Resources and Skills Development Canada. "Level of Education, 15 years of age and over, 1990-2012 (percent)." Indicators of Well-Being in Canada, Learning - Educational Attainment. Accessed October 2013. http://www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=29.

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

The International Comparative Higher Education and Finance Project. "Table 2: Higher Education Expenses Borne by Parents and Students, Canadian Colleges and Universities First Degree [Academic] Year 2009-10" in "Higher Education Finance and Cost-Sharing in Canada." University of Buffalo, The State University of New York, Graduate School of Education. Updated April 2010.

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

Miller, Ronald E. and Peter D. Blair. *Input-Output Analysis: Foundations and Extensions*. New York: Cambridge University Press, 2009.

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

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

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

OECD. "Household savings" in *OECD Factbook 2011-2012: Economic, Environmental and Social Statistics*. OECD Publishing. Accessed June 2013. http://dx.doi.org/10.1787/factbook-2011-22-en.

Parr, J.B. "Regional Economic Development: An Export Stages Framework." *Land Economics* 77, no. 1 (1999): 94–114.

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

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

Public Health Agency of Canada and the Canadian Institute for Health Information. "Figure 15. Estimated Annual Direct and Indirect Costs Associated with Obesity ($ billion), Adults Ages 18 and Older, Canada 2000-2008" in Obesity in Canada. Accessed July 2013. https://secure.cihi.ca/free_products/Obesity_in_canada_2011_en.pdf.

Rhem, J., D. Baliunas, S. Brochu, B. Fischer, W. Gnam, J. Patra, S. Popova, A. Sarnocinska-Hart, and B. Taylor. "The Costs of Substance Abuse in Canada 2002: Highlights." Ottawa, ON: Canadian Centre on Substance Abuse, March 2006.

Roslyn Kunin and Associates. "Economic Impact of International Education in Canada - An Update." Report presented to the Department of Foreign Affairs and International Trade.

Revised May 2012. Accessed October 2013. http://www.international.gc.ca/education/assets/pdfs/economic_impact_en.pdf.

Statistics Canada. "Crimes, by type of violation, and by province and territory." Statistics Canada Summary Tables. Last modified July 2013. Accessed October 2013. http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/legal50a-eng.htm.

Statistics Canada. "Heavy drinking, by sex, provinces and territories." Statistics Canada Summary Tables. Accessed June 2013. http://www.statcan.gc.ca/tables-tableaux/sum-

Statistics Canada. "Income in 2010 (34), Age Groups (10B), Sex (3) and Highest Certificate, Diploma or Degree (11) for the Population Aged 15 Years and Over in Private Households of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2011 National Household Survey." 2011 National Household Survey, Statistics Canada Catalogue no. 99-014-X2011040. Accessed November 2013. http://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/dt-td/Rp-eng.cfm?LANG=E&APATH=3&DETAIL=0&DIM=0&FL=A&FREE=0&GC=0&GID=0&GK=0&GRP=0&PID=106637&PRID=0&PTYPE=105277&S=0&SHOWALL=0&SUB=0&Temporal=2013&THEME=98&VID=0&VNAMEE=&VNAMEF=.som/l01/cst01/health80a-eng.htm.

Statistics Canada. "Labour force characteristics, seasonally adjusted, by province (monthly)." Statistics Canada Summary Tables. Accessed July 2013. http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/lfss01a-eng.htm.

Statistics Canada. "Life Tables, Canada, Provinces and Territories." Catalogue no. 84-537-X. Accessed July 2013. http://www.statcan.gc.ca/pub/84-537-x/84-537-x2013003-eng.pdf.

Statistics Canada. "Smokers, by sex, provinces and territories." Statistics Canada Summary Tables. Accessed June 2013. http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/health74a-eng.htm.

Statistics Canada. "Table 051-0001. Estimates of population, by age group and sex for July 1, Canada, provinces and territories." Statistics Canada CANSIM. Accessed June 2013. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0510001&tabMode=dataTable&srchLan=-1&p1=-1&p2=9#customizeTab.

Statistics Canada. "Table 051-0046. Estimates of population by census metropolitan area, sex and age group for July 1, based on the Standard Geographical Classification (SGC) 2006." Statistics Canada CANSIM. Accessed October 2013. http://www5.statcan.gc.ca/cansim/a05?lang=eng&id=0510046&pattern=0510046&searchTypeByValue=1&p2=35.

Statistics Canada. "Table 051-0052. Estimates of population by census division, sex and age group for July 1, based on the Standard Geographical Classification (SGC) 2006." Accessed October 2013. http://www5.statcan.gc.ca/cansim/pick-choisir?lang=eng&p2=33&id=0510052.

Statistics Canada. "Table 1. Average undergraduate tuition fees for Canadian full-time students, by province." Statistics Canada *The Daily*. Last modified September 2012. Accessed October 2013. http://www.statcan.gc.ca/daily-quotidien/120912/t120912a001-eng.htm.

Statistics Canada. "Table 7: Average income by highest level of education attained, school/work status and gender." Statistics Canada Publication 81-595-M. Accessed June 2013. http://www.statcan.gc.ca/pub/81-595-m/2009075/tbl/tbl7-eng.htm.

Statistics Canada. "Table 10.1: Educational attainment of working-age population, by sex, 1999 to 2009." Statistics Canada Publication 11-402-X. Accessed June 2013. http://www.statcan.gc.ca/pub/11-402-x/2010000/chap/edu/tbl/tbl01-eng.htm.

Statistics Canada. "Table 105-0501: Health indicator profile, annual estimates, by age group and sex, Canada provinces, territories, health regions (2012 boundaries) and peer groups." Statistics Canada CANSIM. Accessed July 2013. http://www5.statcan.gc.ca/cansim/pick-choisir?lang=eng&p2=33&id=1050501.

Statistics Canada. "Table 111-0027. Provincial and international in-, out- and net-migration estimates, by provincial regions." Statistics Canada CANSIM. Accessed October 2013. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1110027&tabMode=dataTable&srchLan=-1&p1=-1&p2=9.

Statistics Canada. "Table 202-0407. Income of individuals, by sex, age group and income source, 2011 constant dollars." Statistics Canada CANSIM. Accessed September 2013. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2020407&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=.

Statistics Canada. "Table 252-0051: Incident-based crime statistics, by detailed violations." Statistics Canada CANSIM. Last modified July 2013. Accessed October 2013. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2520051&paSer=&pattern=&stByVal=1&p1=1&p2=37&tabMode=dataTable&csid=.

Statistics Canada. "Table 282-0002: Labour force survey estimates (LFS), by sex and detailed age group." Statistics Canada CANSIM. Last modified January 2013. Accessed November 2013. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2820002&paSer=&pattern=&stByVal=1&p1=1&p2=37&tabMode=dataTable&csid=.

Statistics Canada. "Table 282-0004: Labour force survey estimates (LFS), by educational attainment, sex and age group." Statistics Canada CANSIM. Accessed July 2013. http://www5.statcan.gc.ca/cansim/pick-choisir?lang=eng&p2=33&id=2820004.

Statistics Canada. "Table 282-0048: Labour force survey estimates (LFS), duration of unemployment by sex and age group." Statistics Canada CANSIM. Accessed October 2013. http://www5.statcan.gc.ca/cansim/pick-choisir?lang=eng&p2=33&id=2820048.

Statistics Canada. "Table 282-0086: Labour force survey estimates (LFS), supplementary unemployment rates by sex and age group." Statistics Canada CANSIM. Last modified January 2013. Accessed July 2013. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2820086&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=.

Statistics Canada. "Table 282-0089. Labour force survey estimates (LFS), employment by class of worker and sex, seasonally adjusted and unadjusted." Statistics Canada CANSIM. Accessed July 2013. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2820089&pattern=282-0069..282-0089&tabMode=dataTable&srchLan=-1&p1=-1&p2=31.

Statistics Canada. "Table 384-0037. Gross domestic product, income-based, provincial and territorial." Statistics Canada CANSIM. Accessed October 2013. http://www5.statcan.gc.ca/cansim/a46?lang=eng&childId=3840037&CORId=3764&viewId=2.

Statistics Canada. "Table 477-0019: Public postsecondary enrolments, by registration status, Pan-Canadian Standard Classification of Education (PCSCE), Classification of Instructional Programs, Primary Grouping (CIP_PG), sex and immigration status." Statistics Canada CANSIM. Accessed July 2013. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=4770019&paSer=&pattern=&stByVal=1&p1=1&p2=31&tabMode=dataTable&csid=.

Statistics Canada. "Time spent on various activities, by sex." Statistics Canada Summary Tables. Accessed June 2013. http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil36a-eng.htm.

Statistics Canada. "Undergraduate tuition fees for full-time Canadian students by discipline, by province." Statistics Canada Summary Tables. Accessed July 2013. http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/educ50a-eng.htm.

Stephens, Thomas and Natacha Joubert. "The Economic Burden of Mental Health Problems in Canada." *Chronic Diseases in Canada* 22, no. 1 (2001): 18-23.

Stone, Charley, Carl Van Horn, and Cliff Zukin. "Chasing the American Dream: Recent College Graduates and the Great Recession." New Brunswick, NJ: Rutgers University, May 2012. Accessed June 2013. http://www.heldrich.rutgers.edu/sites/default/files/content/Chasing_American_Dream_Report.pdf.

Tjepkema, Michael. "Adult obesity in Canada: Measured height and weight." Statistics Canada Analytical Studies and Reports. Accessed July 2013. http://www.aboutmen.ca/application/www.aboutmen.ca/asset/upload/tiny_mce/page/link/Adult-Obesity-in-Canada.pdf.

Willis, Robert J. "Wage Determinants: A Survey and Reinterpretation of Human Capital Earnings Functions." In *Handbook of Labor Economics*, Vol. 1. Edited by Kenneth J. Arrow and Michael D. Intriligator. Amsterdam: Elsevier Science Publishers, 1986: 525-602.

Zhang, Tina. "Cost of Crime in Canada, 2008." Department of Justice Canada Crime Statistics and Research, 2011. Accessed October 2013. http://www.justice.gc.ca/eng/rp-pr/csj-sjc/crime/rr10_5/rr10_5.pdf.

Appendix 2: Glossary of Terms

Alternative education	A "with" and "without" measure of the percent of students who would still be able to avail themselves of education absent the publicly-funded educational institutions in the province. An estimate of 10%, for example, means that 10% of students do not depend directly on the existence of the college in order to obtain their education.
Alternative use of funds	A measure of how monies that are currently used to fund the college might have otherwise been used if the college did not exist.
Asset value	Capitalized value of a stream of future returns. Asset value measures what someone would have to pay today for an instrument that provides the same stream of future revenues.
Attrition rate	Rate at which students leave the regional or provincial workforce due to out-migration, retirement, or death.
Benefit-cost ratio	Present value of benefits divided by present value of costs. If the benefit-cost ratio is greater than 1, then benefits exceed costs, and the investment is feasible.
Credit	A measure of course value generally equal to 15 contact hours of instruction. In general, it requires 450 contact hours or 30 credits to complete one full-time equivalent, or FTE.
Demand	Relationship between the market price of education and the volume of education demanded (expressed in terms of enrollment). The law of the downward-sloping demand curve is related to the fact that enrollment increases only if the price (tuition and fees) is lowered, or conversely, enrollment decreases if price increases.
Discounting	Expressing future revenues and costs in present value terms.
Earnings	Income which is received as a result of labour, *i.e.*, wages and salaries.
Economics	Study of the allocation of scarce resources among alternative and competing ends. Economics is not normative (what ought to be done), but positive (describes what is, or how people are likely to behave in response to economic changes).
Elasticity of demand	Degree of responsiveness of the quantity of education demanded (enrollment) to changes in market prices (tuition and fees). If a decrease in fees increases total revenues, demand is elastic. If it

	decreases total revenues, demand is inelastic. If total revenues remain the same, elasticity of demand is unitary.
Externalities	Impacts (positive and negative) for which there is no compensation. Positive externalities of education include improved social behaviours such as lower crime, reduced unemployment, and improved health. Educational institutions do not receive compensation for these benefits, but benefits still occur because education is statistically proven to lead to improved social behaviours.
Full-time equivalent	The full-time equivalent (FTE) measure is a method of standardizing the actual course loads of students against their normal course loads in order to normalize and combine the institution's full-time and part-time student counts.
Gross regional product	Measure of the final value of all goods and services produced in a region after netting out the cost of goods used in production. Alternatively, gross regional product (GRP) equals the combined incomes of all factors of production, *i.e.*, labour, land and capital. These include wages, salaries, profits, rents, and other. Gross regional product is also sometimes called "value added."
Initial effect	Income generated by the initial injection of monies into the economy through the expenditures of the college and its students.
Input-output analysis	Relationship between a given set of demands for final goods and services and the implied amounts of manufactured inputs, raw materials, and labour that this requires. In an educational setting, when institutions pay wages and salaries and spend money for supplies in the region, they also generate earnings in all sectors of the economy, thereby increasing the demand for goods and services and jobs. Moreover, as students enter or rejoin the workforce with higher skills, they earn higher salaries and wages. In turn, this generates more consumption and spending in other sectors of the economy.
Internal rate of return	Rate of interest which, when used to discount cash flows associated with investing in education, reduces its net present value to zero (*i.e.*, where the present value of revenues accruing from the investment are just equal to the present value of costs incurred). This, in effect, is the breakeven rate of return on investment since it shows the highest rate of interest at which the investment makes neither a profit nor a loss.
Multiplier	The number of times a dollar cycles through the economy, generating additional income and jobs, before leaving the economy. Therefore, a

	multiplier of 1.7 estimates that a dollar will generate an additional $0.70 in the economy before leaving.
Multiplier effect	Additional income created in the economy through multipliers. It consists of the income created by the supply chain of the industries initially affected by the spending of the college and its students (*i.e.*, the direct effect), income created by the supply chain of the initial supply chain (*i.e.*, the indirect effect), and the income created by the increased spending of the household sector (*i.e.*, the induced effect).
Net cash flow	Benefits minus costs, *i.e.*, the sum of revenues accruing from an investment minus costs incurred.
Net present value	Net cash flow discounted to the present. All future cash flows are collapsed into one number, which, if positive, indicates feasibility. The result is expressed as a monetary measure.
Opportunity cost	Benefits forgone from alternative B once a decision is made to allocate resources to alternative A. Or, if individuals choose not to attend college, they forgo earnings that they would have received had they chosen instead to work full-time. Forgone earnings, therefore, are the "price tag" of choosing to attend college.
Payback period	Length of time required to recover an investment—the shorter the period, the more attractive the investment. The formula for computing payback period is: payback period = cost of investment/net return per period.
Return on investment	Net present value of benefits divided by present value of costs. If the return on investment (also referred to as the "ROI") is greater than 0, then the investment is feasible.

Appendix 3: EMSI's Canada Regional Input-Output Model

A3.1 Introduction and data sources

EMSI's Canada Regional Input-Output (CRIO) modeling tool estimates the economic relationships among a region's industries and households. The model provides a unified source for regional economic information but more importantly, it provides the essential vehicle for estimating regional multiplier effects. EMSI constructed the CRIO modeling tool using the most disaggregated and up-to-date regional data available for Canada and applying best input-output modeling practices as indicated by the professional literature. The result is a complex automated process capable of creating regionalized models for any geographic area comprised of Census Division and Census Subdivision areas.

Our primary data sources are the following:

1. Regional and national jobs-by-industry totals, and national sales-to-jobs ratios (derived from EMSI's industry employment and earnings data process).
2. Statistics Canada, "L Level" industry-by-industry input-output tables.
3. Statistics Canada, "S Level" industry-by-industry input-output tables.

A3.2 Creation of the IO coefficients matrix

Table A3.1 illustrates sample amounts that each specific industry purchases from other industries. Industry purchases (inputs) run down the columns, while industry sales (output) run across the rows.

Table A3.1: Sample input-output table (millions)

	Industry 1	Industry 2	…	Households
Industry 1	3.3	1,532.5	…	242.1
Industry 2	9.2	23.0	…	1,982.7
…	…	…	…	…
Households	819.3	2,395.6	…	0

In looking at the table above, the value 1,532.5 means that Industry 2 purchases $1,532,500,000 worth of commodities and/or services from Industry 1. The whole table is an economic double-entry accounting system, configured so that all money inflows have corresponding outflows elsewhere. All regular industries (such as "oil and gas exploration," "machinery manufacturing," "supermarkets," "hospitals," and so on) are captured in the input-output matrix.

Column elements of the input-output table (Table A3.1 above) are "normalized" on column sums (showing the value of total input purchases) to show individual input purchases as percentages of each industry's overall input purchases. Thus, the cell containing .112 In Table A3.2 means that Industry 2 spends 11.2% of its total input purchases to obtain inputs from Industry 1. The matrix

can be viewed as a collection of fixed coefficient production functions. In applied work, the IO coefficients matrix is commonly called the "A" matrix.

Table A3.2: Sample "A" matrix

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

A3.3 Regionalizing the national A matrix

To create a regional input-output model, we "regionalize" a 91 sector version of the Canada national model derived from publicly available Canada national L and S level models. Our regionalization method is based on the work of economist A.T. Flegg[27] and involves the creation of region-specific matrices of modified cross-industry location quotients (CILQ)s. In general, a CILQ indicates the relative importance of the supplying (row) industry to the demanding (column) industry. A CILQ less than 1.0 is taken to indicate a likelihood that the supplying industry's output is insufficient to meet the using industry's overall input demand, and national model IO coefficients are adjusted downward accordingly, with the deficit imported from other regions.[28] Flegg's breakthrough "modification" to the CILQ IO regionalizing approach was the incorporation of a logarithmic term capturing the effects on trade of relative regional size. Flegg's modified CILQ is commonly called the "Flegg LQ," or FLQ formula.

For off-diagonal elements (*i.e.*, where i does not equal j), the CRIO modeling tool utilizes a standard Flegg formulation as follows:

$$FLQ_{i,j} = \left(\frac{\frac{J_i^R}{J_j^R}}{\frac{J_i^N}{J_j^N}} \right) * \left(log_2 \left(1 + \frac{\sum J^R}{\sum J^N} \right) \right)^{\gamma}$$

Where the CILQ (left-hand) multiplicative term has a limiting value of 1.0, and:

---

[27] A.T. Flegg and T. Tohmo, "Regional Input-Output Tables and the FLQ Formula: A Case Study of Finland," *Regional Studies* 47, no. 5 (2013): 703-721; A.T. Flegg and C.D. Webber, "Regional Size, Regional Specialization and the FLQ Formula," *Regional Studies* 34, no. 6 (2000): 563-569; A.T. Flegg and C.D. Webber, "Regional Size, Industrial Location and Input-Output Expenditure Coefficients," *Regional Studies* 32, no. 55 (1997):435-444; A.T. Flegg and C.D. Webber, "On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables: Reply," *Regional Studies* 31, no. 8 (1997): 795-805; A.T. Flegg and C.D. Webber, "On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables," *Regional Studies* 29, no. 6 (1994): 547-561.

[28] For a complete discussion of CILQ IO regionalizing methods, see Chapter 8 in Ronald E. Miller and Peter D. Blair, *Input-Output Analysis: Foundations and Extensions* (New York: Cambridge University Press, 2009).

J = jobs

i = row industry

j = column industry

R = region

N = nation

γ = calibrating power term

For diagonal elements (*i.e.*, where i equals j) and for the household column, we follow Flegg and apply a standard simple location quotient, again with a ceiling of 1.0:

$$FLQ_{i,j} = \left(\frac{\frac{J_i^R}{\sum J^R}}{\frac{J_i^N}{\sum J^N}} \right) * \left(log_2 \left(1 + \frac{\sum J^R}{\sum J^N} \right) \right)^{\gamma}$$

One final model element needs regionalizing, and that is the household row. The regionalizing term for the household row indicates the proportion of total labour requirements obtained from workers residing in the region. Lacking region specific data on commuting, we assume a household row regionalizing factor of 75%, thereby assuming that 25% of labour needs are provided by regional in-commuters.

Consider next the calibrating power term gamma shown in the Flegg equations above. The most recent empirical tests of the Flegg LQ approach suggest an optimal value for the calibrating term equal to roughly 0.2,[29] although EMSI comparisons of the Canada Flegg model and the EMSI IO US model suggest a value of 0.1 is better suited for the more dispersed regional economies of North America.

Let us return again to our illustrative FLQ regionalizing process. Based on the formulation presented above, we create a separate matrix of FLQs for all industries in a region. For example, the cell containing the FLQ of .12 in Table A3.3 was calculated by using Industry 1 as the row industry (or i in the Flegg equation above) and Industry 2 as the column industry (or j in the Flegg equation above). The FLQ is interpreted as measuring the proportion of regional requirements of input i by sector j that is satisfied by firms located in the region. In our example above, 12% of Industry 2's demand for the output of Industry 1 are satisfied by local Industry 1. The remaining 88% (= 100% - 12%) of demand is assumed to be imported. On this definition, the matrix of FLQ's can be interpreted as a matrix of "regional trade coefficients."

[29] Flegg et al., "Regional Input-Output Tables and the FLQ Formula," 703-721.

Table A3.3: Sample FLQ matrix

	Industry 1	Industry 2	…	Households
Industry 1	.88	.12	…	.47
Industry 2	.98	1	…	.09
…	…	…	…	…
Households	.20	.76	…	1

The "regionalizing" process is completed by computing the element-by-element product of region-based FLQs, interpreted as regional trade coefficients, and national input-output coefficients, interpreted as technical coefficients. The result is a matrix of regional input-output coefficients.

Consider the mathematics. The regional FLQ matrix is constructed with the same dimensions as the national A matrix. Industries that do not exist in the region appear in the Flegg matrix with zero rows and zero columns. The element-by-element product appears then as follows:

$A^R = A^N \, o \, F^R$

Where:

o = Hadamard (element-by-element) multiplication

A^N = national IO coefficients matrix (*i.e.*, technical coefficients)

F^R = FLQ matrix

A^R = regional IO coefficients matrix

A3.4 Estimating regional input-output multiplier effects

The most important use of regional input-output models is the estimation of regional multiplier effects. Regional IO multiplier analysis has a long tradition in regional science, and is nowadays viewed as the exclusive method for estimating regional multiplier effects. Following standard practice, input-output multiplier effects are estimated via the regional IO multiplier matrix derived from identity matrix I and the regional IO coefficients matrix A^R as follows:

$B^R = (I - A^R)^{-1}$

Where:

B^R = multiplier matrix for region R

Given a unit change (*i.e.*, dollar change) in column industry activity (called the "initial" change), multiplier matrix elements show the resulting direct, indirect and induced change in row industry sales. "Direct" change refers to resulting input purchases. "Indirect" change refers to additional input purchases created as a result of the direct purchases. "Induced" change refers to sales resulting from the spending of newly-created household incomes. Job and income effects are obtained by computing jobs-to-sales and income-to-sales ratios and applying these to regional multiplier matrix elements.

Appendix 4: Value per Credit and the Mincer Function

Two key components in determining the economic impact and return on investment of education are 1) the value of the students' educational achievements, and 2) the change in that value over the students' working careers. Both of these components are described in detail in this appendix.

A4.1 Value per credit

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

To calculate the value per credit, we first determine how many credits are required to complete each education level. For example, assuming that one full-time equivalent (FTE) is equal to 30 credits, a student generally completes 60 credits (or two full-time years' worth of study) in order to move from a high school diploma to a two-year diploma, another 60 credits to move from a two-year diploma to a bachelor's degree, and so on. This progression of credits generates an education ladder beginning at the less than high school level and ending with the completion of a doctoral degree, with each level education representing a separate stage in the progression.

The second step is to assign a unique value to the credits in the education ladder based on the wage differentials presented in Table 1.7. For example, the difference in earnings between a high school diploma and a two-year diploma is $13,500. We spread this $13,500 wage differential across the 60 credits that occur between the high school diploma and the two-year diploma, applying a ceremonial "boost" to the last credit in the stage to mark the achievement of the degree.[30] We repeat this process for each education level in the ladder.

Of course, several other factors such as ability, socioeconomic status, and family background also positively correlate with higher earnings. Failure to account for these factors results in what is known as an "ability bias." Research by Card (1999) indicates that the upper limit benefits defined

[30] Economic theory holds that workers that acquire education credentials send a signal to employers about their ability level. This phenomenon is commonly known as the "sheepskin" or "signaling" effect. The ceremonial boosts applied to the achievement of degrees in the EMSI college impact model are derived from Ana Ferrer and Craig Riddell, "The role of credentials in the Canadian labour market," *Canadian Journal of Economics* 35, no. 4 (November 2002): 879-905.

by correlation should be discounted by 10%.[31] As such, we reduce the marginal differences between education levels by 10%.

Next we map the credit production of Algonquin's 2012-13 student population to the education ladder. Table 1.4 provides information on the credit production of Algonquin's students broken out by educational achievement. In total, students completed 613,671 credits during the analysis year, excluding the credit production of personal enrichment students. We map each of these credits to the education ladder depending on the students' education level and the average number of credits they completed during the year. For example, two-year diploma graduates are allocated to the stage between the high school diploma and the two-year diploma, and the average number of credits they complete informs the shape of the distribution curve used to spread out their total credit production within that stage of the progression.

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

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

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

Table A4.1 displays the result for students' aggregate annual increase in earnings (ΔE), a total of $130.3 million. By dividing this value by the students' total production of 613,671 credits during the analysis year, we derive an overall average value of $212 per credit.

Table A4.1: Aggregate annual increase in earnings of Algonquin students and average value per credit

Aggregate annual increase in earnings	$130,287,206
Total credits in FY 2012-13*	613,671
Average value per credit	$212

* Excludes the credit production of leisure students.

Source: EMSI college impact model.

A4.2 Mincer Function

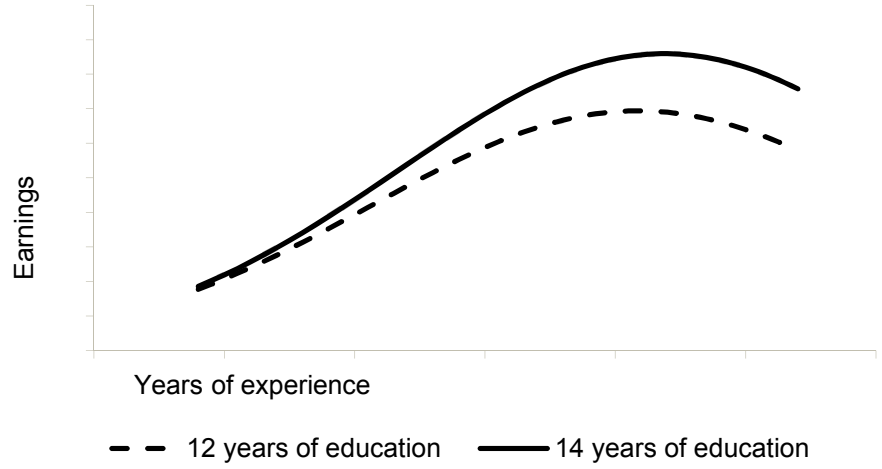
The $212 value per credit in Table A4.1 only tells part of the story, however. Human capital theory holds that earnings levels do not remain constant; rather, they start relatively low and gradually increase as the worker gains more experience. Research also shows that the earnings increment

[31] David Card, "The causal effect of education on earnings," *Handbook of Labor Economics* 3 (1999): 1801-1863. Card acknowledges that ability is unobservable and the instrumental variable techniques for measuring the ability bias are different. He concludes that the "best available" evidence suggests a "small upward bias (on the order of 10%)."

between educated and non-educated workers grows through time. These basic patterns in earnings over time were originally identified by Jacob Mincer, who viewed the lifecycle earnings distribution as a function with the key elements being earnings, years of education, and work experience, with age serving as a proxy for experience.[32] Mincer's earnings function is still upheld in recent data and has served as the foundation for a variety of research pertaining to labour economics.

Figure A4.1 illustrates several important points about the Mincer function. First, as demonstrated by the shape of the curves, an individual's earnings initially increase at an increasing rate, then increase at a decreasing rate, reach a maximum somewhere well after the midpoint of the working career, and then decline in later years. Second, individuals with higher levels of education reach their maximum earnings at an older age compared to individuals with lower levels of education (recall that age serves as a proxy for years of experience). And third, the benefits of education, as measured by the difference in earnings between education levels, increase with age.

Figure A4.1: Lifecycle change in earnings, 12 years versus 14 years of education



In calculating the past students' productivity effect in Chapter 2, we use the slope of the curve in Mincer's earnings function to condition the $212 value per credit to the students' age and work experience.[33] To the students just starting their career during the analysis year, we apply a lower

[32] See Mincer, 1958 and Jacob Mincer, "Schooling, Experience and Earnings" (New York: National Bureau of Economic Research, 1974). See also Gary S. Becker, *Human Capital: a Theoretical Analysis with Specific Reference to Education* (New York: Columbia College Press for NBER, 1964).

[33] The Mincer equation is computed based on estimated coefficients presented in Robert J. Willis, "Wage Determinants: A Survey and Reinterpretation of Human Capital Earnings Function" in *Handbook of Labor Economics*, Vol. 1 (Amsterdam: Elsevier Science Publishers, 1986): 525–602. These are adjusted to current year dollars in the usual fashion by applying the GDP implicit price deflator. The function does not factor in temporary economic volatility, such as high growth periods or recessions. In the long run, however, the Mincer function is a reasonable predictor.

value per credit; to the students in the latter half or approaching the end of their careers we apply a higher value per credit. The original $212 value per credit applies only to the credit production of students precisely at the midpoint of their careers during the analysis year.

In Chapter 3 we again apply the Mincer function, this time to project the benefits stream of Algonquin's 2012-13 student population into the future. Here too the value per credit is lower for students at the start of their career and higher near the end of it, in accordance with the scalars derived from the slope of the Mincer curve illustrated in Figure A4.1.

A4.3 Conclusion

This appendix demonstrates the significance of the value per credit and the Mincer function in determining the initial effect of past students' productivity on the regional economy in Chapter 2 and the students' return on their educational investment in Chapter 3. Both chapters provide further discussion on the role that the students' credit production and corresponding increase in earnings plays in calculating the study outcomes.

Appendix 5: Alternative Education Variable

In a scenario where Algonquin did not exist, some of its students would still be able to avail themselves of an education. These students create benefits in the region even in the absence of Algonquin. The alternative education variable is an estimate of this portion of students and is used to discount the benefits we attribute to Algonquin. This appendix outlines the theoretical framework and data used in estimating the alternative education variable.

A5.1 Theory

The estimation of the alternative education variable is essentially an estimation of the Algonquin students' demand for an alternative institution, where the alternative institution is the closest peer education institution in the region. Student demand for education is determined by a number of different factors. Among the most important of these factors are tuition price and distance. The more students have to pay in tuition and the further they have to travel to receive an education, the less likely they are to enroll.[34] Using tuition prices and distances, we estimate the alternative education variable *(AE)* as the reduction in enrollment at institution j given the alternative institution a.

We estimate the alternative education as a function of the costs of attending institution j and the alternative institution a:

$$AE = f(C_j, C_a)$$

Where:

C_j = Cost of attendance per student at institution j

C_a = Cost of attendance per student at alternative institution a

The cost of attendance at institution j (C_j) is assumed to be equal to the tuition price per student at institution j (P_j). Thus:

$$C_j = P_j$$

For institution a, the cost of attendance per student (C_a) is represented by the following equation:

$$C_a = P_a + M_a$$

[34] For more discussion on the impact of price and distance on an individual's decision to enroll in higher education, see Andy Dickerson and Steven McIntosh, "The Impact of Distance to Nearest Education Institution on the Post Compulsory Education Participation Decision," *Urban Studies* 50 no. 4 (2013): 742-758. See also Stijn Kelchtermans and Frank Verboven, "Participation and Study Decisions in a Public System of Higher Education," *Journal of Applied Econometrics* 25 (2010): 355-391.

Where:

P_a = Tuition price per student at alternative institution a

M_a = Additional transportation costs as a result of increased distance to institution a, including the opportunity cost of wages forgone as a result of increased travel time to institution a

Combining the tuition prices and the costs associated with distance, we control for the substitution and income effects of attending the alternative institution.

A5.2 Data

Tuition prices for public and private institutions by province were gathered from Statistics Canada. The opportunity cost of wages forgone and the additional transportation cost (M_a) are dependent on the distance (d) and travel time (t) between institution j and a. Travel time (t) is measured in terms of hours and is a function of d (measured in terms of kilometers) and the average number of kilometers that an individual can travel in one hour. In this analysis, we assume the average speed to be 50 kilometers per hour. Accordingly, travel time (t) is calculated as follows:

$t = d / 50$

The distance (d) between institution j and alternative institution a is dependent upon the latitude (θ) and longitude (τ) of institutions j and a. Latitudes and longitudes for all private and public institutions were derived using their physical addresses. We measure distance between institutions in accordance with the standard haversine formula, as follows:[35]

$$d\left(f\left(\theta_{(j,a)}, \tau_{(j,a)}\right)\right) = 2R * \left\{arcsin\left(\sqrt{sin^2\left(\frac{\theta_a - \theta_j}{2}\right) + cos(\theta_j)cos(\theta_a)sin^2\left(\frac{\tau_a - \tau_j}{2}\right)}\right)\right\}$$

Where:

R = Earth's radius, a total 6,371 kilometers

Having established t and d, the opportunity cost of wages forgone and additional transportation costs, (M_a) may now be determined. The equation for M_a is:

$M_a = t * w * e * 160 + 2 * d * 0.66 * 160$

Such that $d \geq 0$

And where w is hourly wages per student, e is the percent of students who are employed at institution j, 160 is the number of days in a standard academic year, and \$0.66 is the average driving

[35] The harversine formula is used in navigation to calculate the great-circle distance between two points on a sphere given their latitudes and longitudes.

cost (in terms of dollars) per kilometer. The average cost per kilometer is an estimate provided by the Canadian Automobile Association. Hourly wages *(w)* are conservatively estimated to be equal to the minimum hourly wage in the province where institution j is located. Information on minimum wage rates by province is available from the Government of Canada.

A5.3 Estimation

The previous equations set the parameters for calculating the cost of attendance at institutions j and a based on tuition prices and distances. We now apply an arc price elasticity of demand function to calculate the percent reduction in enrollment at institution j should a portion of its students choose instead to attend institution a. The equation is as follows:

$$AE = \frac{\varepsilon_d * (C_a - C_j) + (C_a + C_j)}{(C_a + C_j) - \varepsilon_d * (C_a + C_j)}$$

Where ε_d represents the elasticity of demand and is equal to an assumed value of -.75.

The result of this equation *(AE)* is the alternative education variable used in the counterfactual adjustments to the past students' productivity effect in Chapter 2 and the social and provincial government investment analysis in Chapter 3. More information on how the alternative education variable is applied in these analyses is provided in the main body of the report.

Appendix 6: Overview of Investment Analysis Measures

The purpose of this appendix is to provide context to the investment analysis results using the simple hypothetical example summarized in Table A6.1 below. The table shows the projected benefits and costs for a single student over time and associated investment analysis results.[36]

Table A6.1: Example of the benefits and costs of education for a single student

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			**$21,500**	**$35,753**	**$14,253**
Internal rate of return					**18%**
Benefit-cost ratio					**1.7**
Return on investment					**0.7**
Payback period					**4.2 years**

Assumptions are as follows:

1. Benefits and costs are projected out ten years into the future (Column 1).
2. The student attends the college for one year, and the cost of tuition is $1,500 (Column 2).
3. Earnings forgone while attending college for one year (opportunity cost) come to $20,000 (Column 3).
4. Together, tuition and earnings forgone cost sum to $21,500. This represents the out-of-pocket investment made by the student (Column 4).
5. In return, the student earns $5,000 more per year than he would have otherwise earned without the education (Column 5).

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

6. The net cash flow (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, the internal rate of return, the benefit-cost ratio, the return on investment, and the payback period. Each of these is briefly explained below in the context of the cash flow numbers presented in Table A6.1.

A6.1 Net present value

The student in Table A6.1 can choose either to attend college or to forgo post-secondary education and maintain their present employment. If they decide to enroll, certain economic implications unfold. Tuition and fees must be paid, and earnings will cease for one year. In exchange, the student calculates that with post-secondary education, their earnings will increase by at least the $5,000 per year, as indicated in the table.

The question is simple—will the prospective student be economically better off by choosing to enroll? If he adds up higher earnings of $5,000 per year for the remaining nine years in Table 1, the total will be $45,000. Compared to a total investment of $21,500, this appears to be a very solid investment. The reality, however, is different. Benefits are far lower than $45,000 because future money is worth less than present money. Costs (tuition plus earnings forgone) are felt immediately because they are incurred today, in the present. Benefits, on the other hand, occur in the future. They are not yet available. All future benefits must be discounted by the going rate of interest (referred to as the discount rate) to be able to express them in present value terms.[37]

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 (in this example, tuition plus earnings forgone). As indicated in Table A6.1, the cumulative present value of $5,000 worth of higher earnings between years 2 and 10 is $35,753 given the 4% interest rate, far lower than the undiscounted $45,000 discussed above.

---

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

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

A6.2 Internal rate of return

The internal rate of return is another way of measuring the worth of investing in education using the same cash flows shown in Table A6.1. In technical terms, the internal rate of return is a measure of the average earning power of money used over the life of the investment. It is simply the interest rate that makes the net present value equal to zero. In the discussion of the net present value above, the model applies the "going rate" of interest of 4% and computes a positive net present value of $14,253. The question now is what the interest rate would have to be in order to reduce the net present value to zero. Obviously it would have to be higher—18% in fact, as indicated in Table A6.1. Or, if a discount rate of 18% were applied to the net present value calculations instead of the 4%, then the net present value would reduce to zero.

What does this mean? The internal rate of return of 18% 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%, higher earnings of $5,000 per year for the next nine years will earn back all investments of $21,500 made plus pay 18% 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% is far higher than 4%. It may be concluded, therefore, that the investment in this case is solid. Alternatively, comparing the 18% 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 approach for calculating the internal rate of return can sometimes generate wild or unbelievable results that defy the imagination. Technically, the approach requires at least one negative cash flow to offset all subsequent positive flows. For example, if the student works full-time while attending college, the opportunity cost of time would be much lower. The only out-of-pocket cost would be the $1,500 paid for tuition. In this case, it would still be possible to compute the internal rate of return, but it would be a staggering 333% because only a negative $1,500 cash flow would be offsetting nine subsequent years of $5,000 worth of higher earnings. Although the 333% return would technically be correct, it would not be consistent with the conventional understanding of returns expressed as percentages.

A6.3 Benefit-cost ratio

The benefit-cost ratio is simply the present value of benefits divided by present value of costs, or $35,753 ÷ $21,500 = 1.7 (based on the 4% discount rate). Of course, any change in the discount rate would also change the benefit-cost ratio. Applying the 18% internal rate of return discussed above would reduce the benefit-cost ratio to 1.0, the breakeven solution where benefits just equal costs. Applying a discount rate higher than the 18% 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.

A6.4 Return on investment

The return on investment is similar to the benefit-cost ratio, except that it measures the net (as opposed to gross) benefits of an investment relative to the investment's cost. In terms of dollars, the return on investment represents the benefits received over and above the original investment. It is calculated simply by dividing the net present value of the benefits by the total costs of the investment, or $15,080 ÷ $21,500 = 0.7 (again based on the 4% discount rate). This means that the investment will return the original cost of the investment plus an additional $.70 for every dollar invested. A positive value for the return on investment measure (*i.e.*, any value above 0) indicates that the investment has been profitable.

A6.5 Payback period

This is the length of time from the beginning of the investment (consisting of tuition and earnings forgone) until higher future earnings give a return on the investment made. For the student in Table A6.1, it will take roughly 4.2 years of $5,000 worth of higher earnings to recapture his investment of $1,500 in tuition and the $20,000 in earnings forgone while attending college. Higher earnings that occur beyond 4.2 years are the returns that make the investment in education in this example economically worthwhile. The payback period is a fairly rough, albeit common, means of choosing between investments; the shorter the payback period, the stronger the investment.

Appendix 7: Shutdown Point

The investment analysis in Chapter 3 weighs the benefits generated by the college against the provincial government funding that the college receives to support its operations. An important part of this analysis is factoring out the benefits that the college would have been able to generate anyway, even without provincial government support. This adjustment is used to establish a direct link between what the Ontario government pays and what it receive in return. If the college is able to generate benefits without provincial government support, then it would not be a true investment.[38]

The overall approach includes a sub-model that simulates the effect on student enrollment if the college loses its provincial funding and has to raise student tuition and fees in order to stay open. If the college can still operate without provincial 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 underlying theory behind these adjustments.

A7.1 Provincial government support versus student demand for education

Figure A7.1 presents a simple model of student demand and provincial 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 full-time equivalents (FTEs) and expressed as a percentage of the college's current FTE production. Current student tuition and fees are represented by p', and provincial 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) provincial government support.

[38] Of course, as a public training provider, Algonquin would not be permitted to continue without public funding, so the situation in which it would lose all provincial support is entirely hypothetical. The purpose of the adjustment factor is to examine Algonquin 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 A7.1

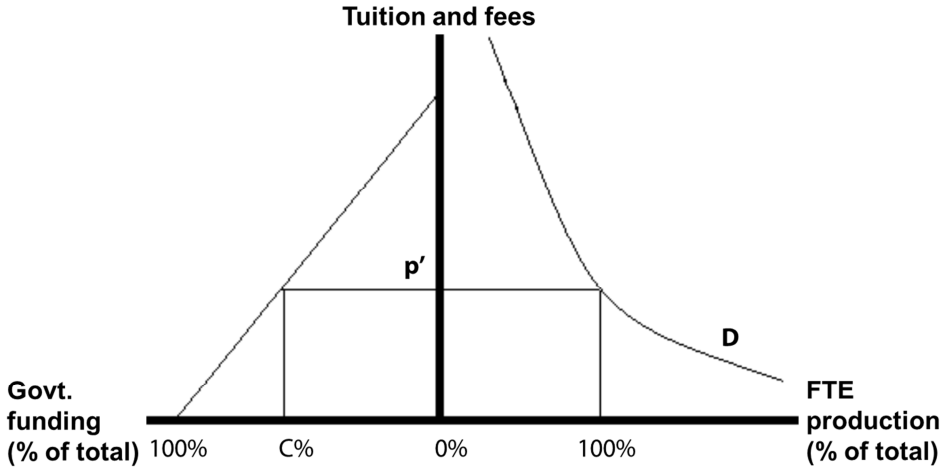
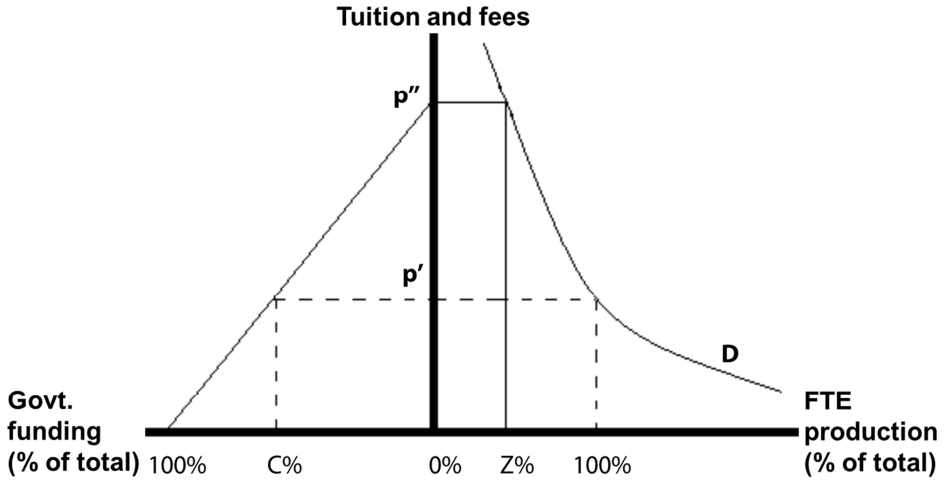


Figure A7.2 shows another important reference point in the model—where provincial government support is 0%, student tuition and fees are increased to *p″*, and the FTE production is at *Z%* (less than 100%). The reduction in FTEs reflects the price elasticity of the students' demand for education, *i.e.*, the extent to which the students' decision to attend college is affected by the change in tuition and fees. Ignoring 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 to provincial government must be adjusted to net out the benefits that the college can provide absent provincial government support, represented as *Z%* of the college's current FTE production in Figure A7.2.

Figure A7.2



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

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

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

Consider benefits now with reference to Figure A4.2. The point at which provincial 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 equation 2 occur with or without provincial government support, the benefits appropriately attributed to provincial government support are given by equation 3 as follows:

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

A7.2 Calculating benefits at the shutdown point

Colleges cease to operate when the revenue they receive from the quantity of education demanded is insufficient to justify their continued operations. This is commonly known in economics as the shutdown point. The shutdown point is introduced graphically in Figure A7.3 as $S\%$. The location of point $S\%$ indicates that the college can operate at an even lower enrollment level than $Z\%$ (the point at which the college receives zero provincial government funding). Provincial government support at point $S\%$ is still zero, and student tuition and fees have been raised to p'''. Provincial support is thus credited with the benefits given by equation 3, or $B = B\ (100\%) - B\ (Z\%)$. With student tuition and fees still higher than p''', the college would no longer be able to attract enough students to keep the doors open, and it would shut down.

Figure A7.3

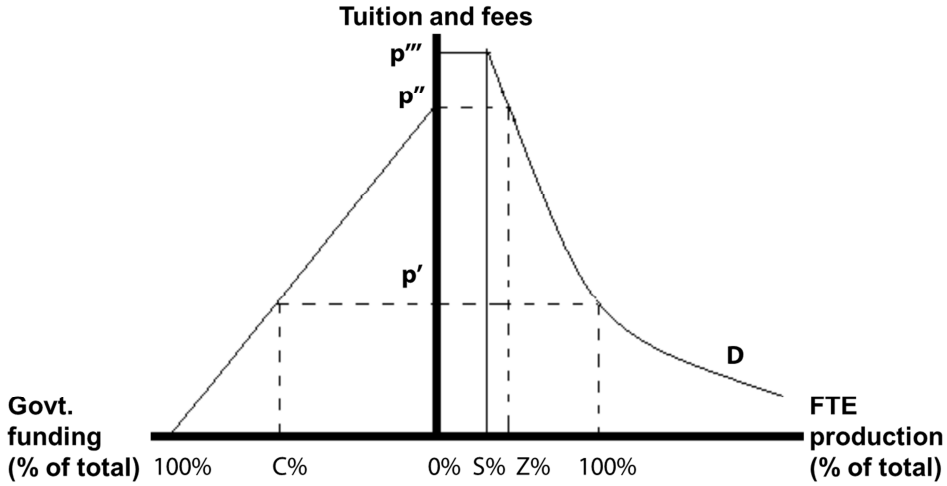
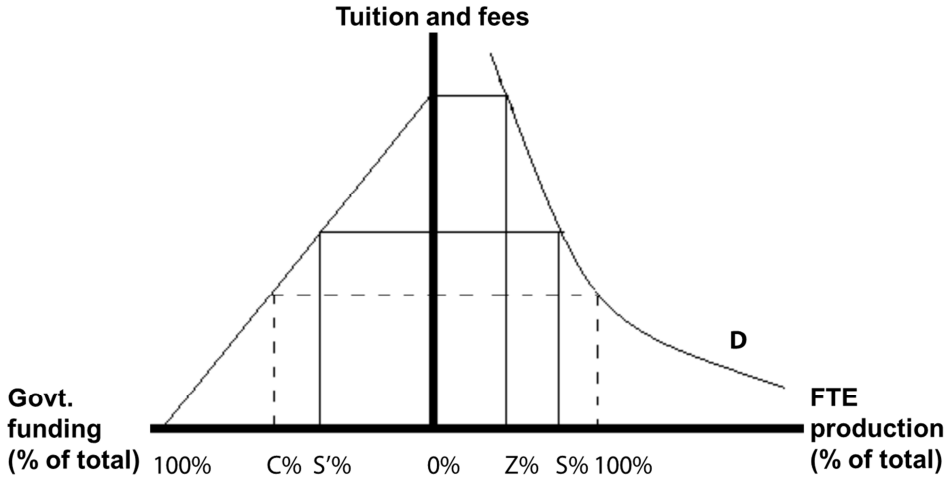


Figure A7.4 illustrates yet another scenario. Here the shutdown point occurs at a level of FTE production greater than *Z%* (the level of zero provincial government support), meaning some minimum level of provincial government support is needed for the college to operate at all. This minimum portion 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, provincial government support is appropriately credited with all the benefits generated by the college's FTE production, or *B = B (100%)*.

Figure A7.4



Appendix 8: Social Externalities

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

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

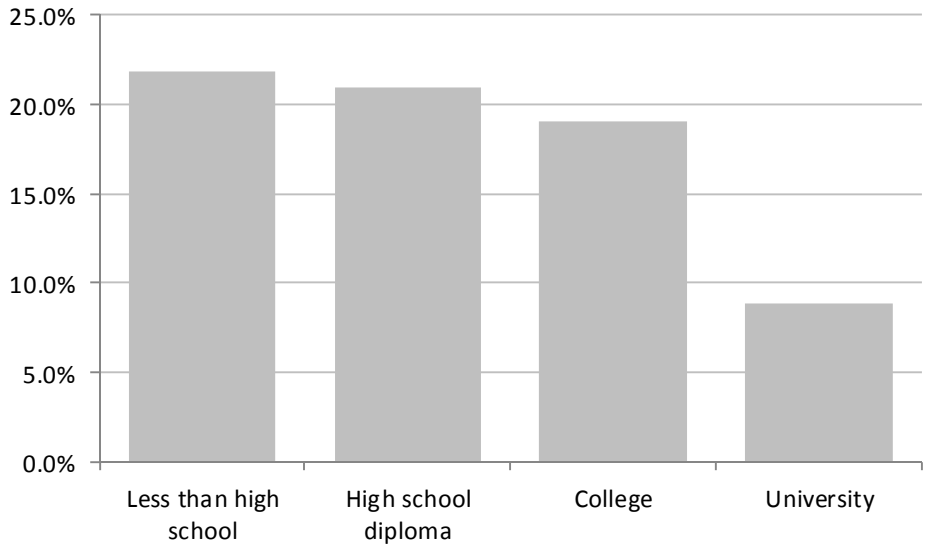
A8.1 Health

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

A8.1.1 Smoking

Figure A8.1 shows the prevalence of cigarette smoking among adults aged 15 years and over, based on data provided by the Health Canada Canadian Tobacco Use Monitoring Survey (CTUMS). As indicated, the percent of persons who smoke begins to decline beyond the level of less than high school.

Figure A8.1: Prevalence of smoking by education level



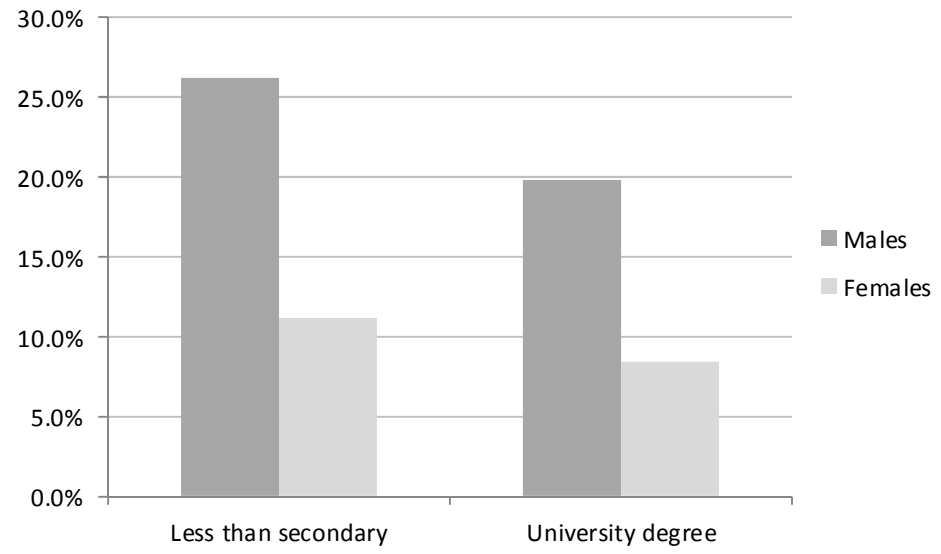
The Health Canada CTUMS also reports the percentage of adults who are current smokers by province. We use this information to create an index value by which we adjust the national prevalence data on smoking to each province. For example, 16.3% of Ontario's adults were smokers in 2011, relative to 17.3% for the nation. We thus apply a scalar of 0.9 to the national probabilities of smoking in order to adjust them to the province of Ontario.

A8.1.2 Alcohol abuse

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

Figure A8.2 compares the prevalence rate of heavy drinking among males and females aged 15 at the less than secondary level to the prevalence rate at the university degree level, based on data supplied by Statistics Canada and the Canadian Center on Substance Abuse Canadian Addiction Survey (CAS). These statistics give an indication of the correlation between education and the reduced probability of alcoholism. As indicated, heavy drinking falls from a 26.2% prevalence rate among males at a less than secondary level to a 19.9% prevalence rate among males with a university degree. Similarly, heavy drinking among females ranges from a 11.2% prevalence rate at the less than secondary level to a 8.5% prevalence rate at the university degree level.

Figure A8.2: Prevalence of heavy drinking by sex and education level

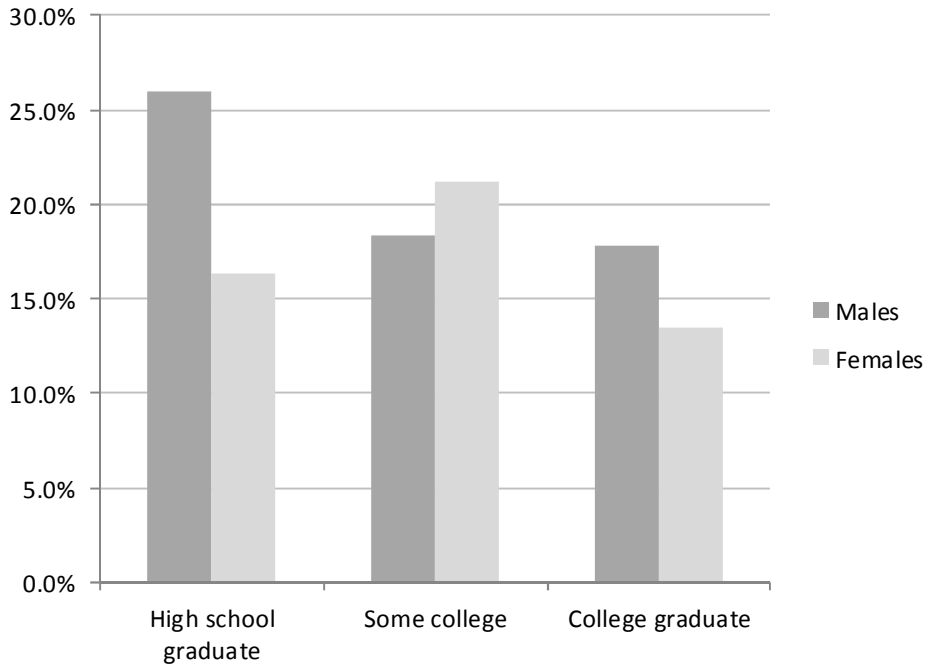


A8.1.3 Obesity

The rise in obesity and diet-related chronic diseases has led to increased attention on how expenditures relating to obesity have increased in recent years. The economic burden of obesity consists of both the direct costs to the health care system and the indirect costs to productivity, as defined and measured by a joint report from the Public Health Agency of Canada and the Canadian Institute of Health Information.[39]

Figure A8.3 shows the prevalence of obesity among adults aged 18 years and over by education and sex, based on data supplied by Statistics Canada. As indicated, college graduates are less likely to be obese than individuals with a high school diploma. However, the prevalence of obesity among females with some college is actually greater than females with no more than a high school diploma. In general, though, obesity tends to decline with increasing levels of education.

Figure A8.3: Prevalence of obesity by education level



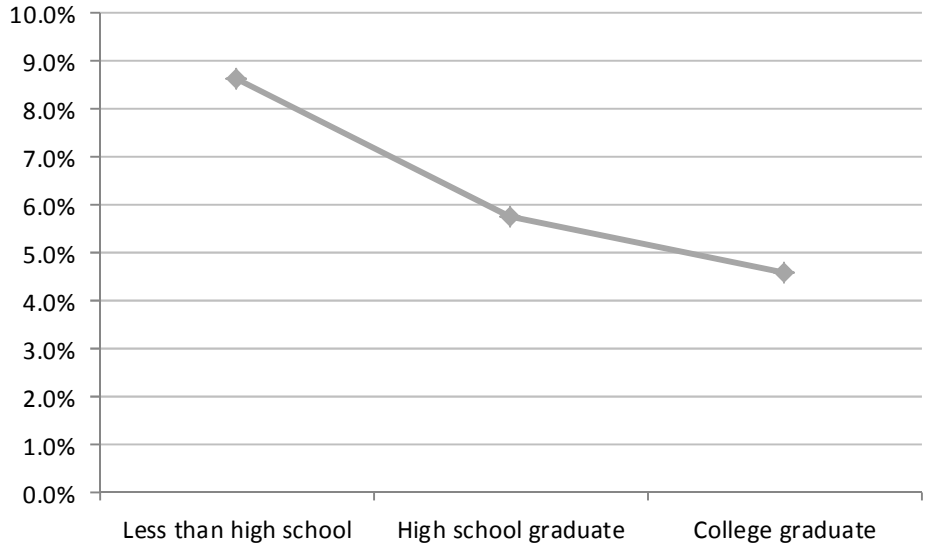
A8.1.4 Mental illness

The economic burden of mental health problems in Canada includes the cost of treatment and lost productivity in the workplace. Figure A8.4 summarizes the prevalence rate among adults aged 15 years and older that perceive their mental health to be fair or poor by education level, based on combined data from Statistics Canada and the Government of Canada. As shown, college graduates

[39] Public Health Agency of Canada and the Canadian Institute for Health Information, *Obesity in Canada,* accessed July 2013, https://secure.cihi.ca/free_products/Obesity_in_canada_2011_en.pdf.

are less likely to suffer from fair or poor mental health than someone with a secondary or less than secondary education, with the prevalence of mental illness being the highest among people without a high school diploma.

Figure A8.4: Prevalence of fair or poor mental health by education level

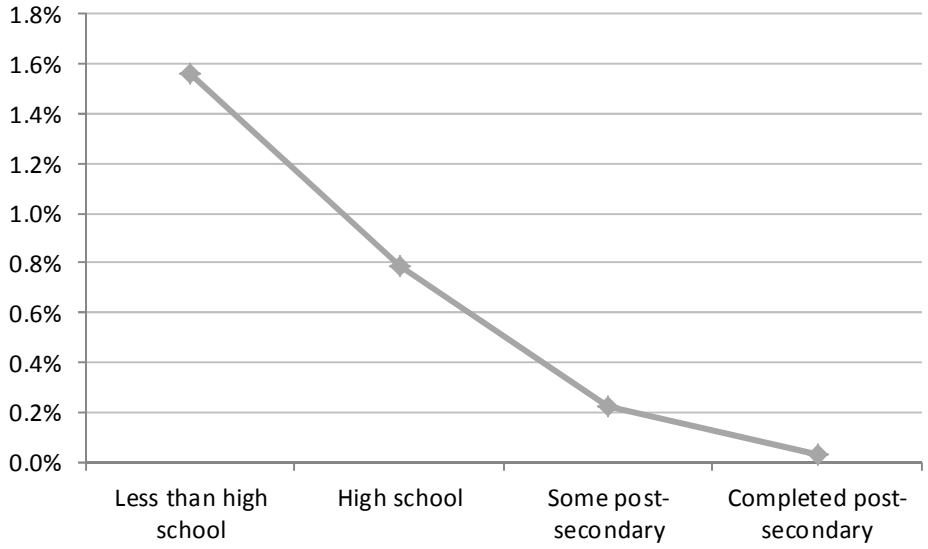


A8.2 Crime

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

Figure A8.5 displays the probability that an individual will be placed in custody by education level. Data are derived from the breakdown of adults in correctional services by province as provided by combined data from Statistics Canada and the Canadian Centre for Justice Statistics, divided by the total adult population. As indicated, the probability of being placed in custody drops on a sliding scale as education levels rise.

Figure A8.5: Percent of adult population that are in custody by education level



Victim costs comprise health care, productivity losses, stolen/damaged property, and third-party costs (including victim services). Some of these costs are hidden, while others are available in various databases. Estimates of victim costs vary widely, attributable to differences in how the costs are measured. The lower end of the scale includes only tangible out-of-pocket costs, while the higher end includes intangible costs related to pain and suffering.

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

A8.3 Income assistance

Statistics show that as education levels increase, the unemployment rate declines, as shown in Figure A8.6. These data are supplied by the Statistics Canada Labour Force Survey (LFS). Unemployment rates range from 15.0% for those with less than a high school diploma to 5.2% for those at the bachelor's degree level.

Figure A8.6: Unemployment rates by education level

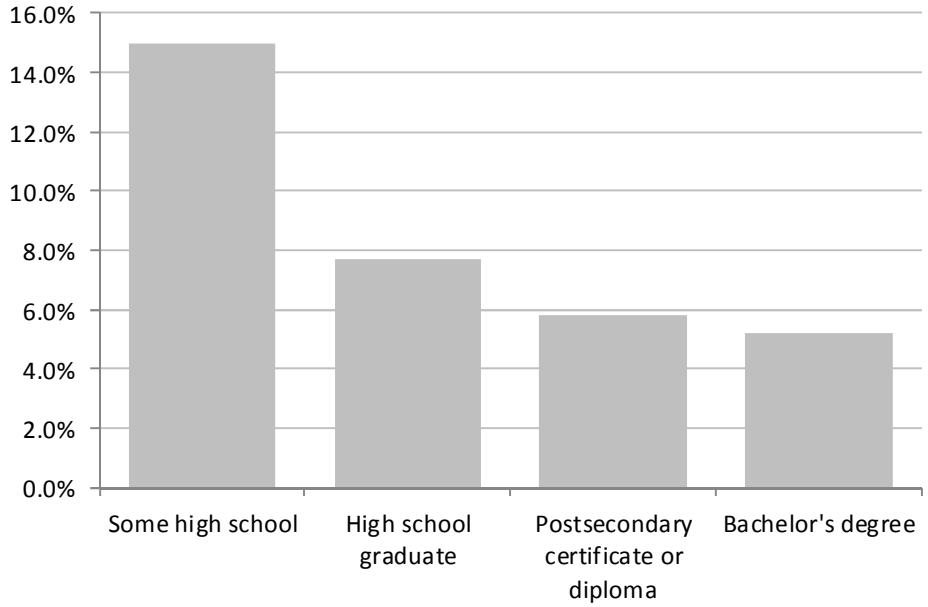
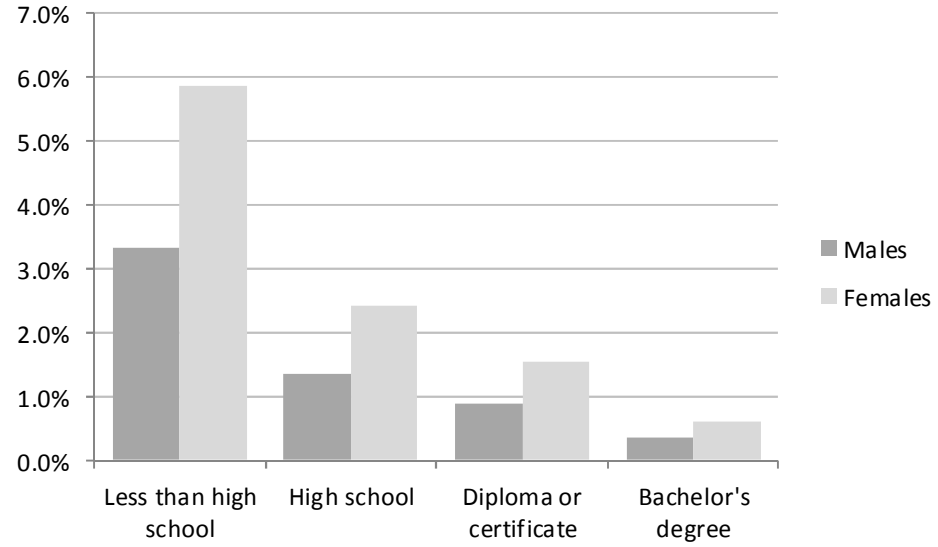


Figure A8.7 relates the breakdown of employment-related social assistance recipients by gender and education level, derived from data supplied by Statistics Canada, the Centre for Urban and Community Studies, and the Federal-Provincial-Territorial Directors of Income Support. As shown, the demographic characteristics of social assistance recipients are weighted heavily towards the less than high school and high school categories, with a much smaller representation of individuals with greater than a high school education.

Figure A8.7: Probability of claiming employment-related social assistance by gender and education level



A8.4 Conclusion

The statistical databases bear out the simple correlation between education and improved health, lower custody rates, and fewer claimants of income assistance. 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 education.