ANALYSIS OF THE RETURN ON INVESTMENT
AND ECONOMIC IMPACT OF EDUCATION

Demonstrating the Value of Calgary's Postsecondary Institutions

November 2016

MAIN REPORT

Emsi

Contents

Acknowledgements

Emsi gratefully acknowledges the excellent support of the staff at Calgary's Postsecondary Institutions (Calgary PSIs) and Calgary Economic Development in making this study possible. Special thanks go to Court Ellingson, Vice President for Research and Strategy, Calgary Economic Development, who approved the study; and to Jeanette Sutherland, Manager for Workforce and Productivity, and David Ducasses, Research Manager for Research and Strategy, both from Calgary Economic Development, who helped liaise with the PSIs; and to the individuals at the PSIs, 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.

ABOUT CALGARY ECONOMIC DEVELOPMENT

This economic impact study was commissioned on behalf of Calgary's postsecondary education institutions by Calgary Economic Development (CED). CED is a non-profit organization that works with local, national, and international partners from the business, community, and government spheres to advance Calgary's position as a high-quality choice for investment, trade, and economic growth.

Introduction

Calgary's Postsecondary Institutions (Calgary PSIs) create value in many ways. The institutions play a key role in helping students increase their employability and achieve their individual potential. With a wide range of program offerings, Calgary PSIs enable students to earn credentials and develop the skills they need in order to have fulfilling and prosperous careers. The institutions also provide excellent environments for students to meet new people and make friends, while participation in courses improves 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 Calgary PSIs[1] consists of more than solely influencing the lives of students. The institutions' program offerings support a range of industry sectors in the Calgary Census Metropolitan Area and supply employers with the skilled workers they need to make their businesses more productive. Operational and research expenditures of Calgary PSIs, along with the spending of their employees, students, visitors, and entrepreneurial activities, further support the regional economy through the output and employment generated by regional businesses. Research activities of Calgary PSIs improve the quality of life and advancement of society in the Calgary Census Metropolitan Area through medical breakthroughs and the creation of new technology. Lastly, and just as importantly, the economic impact of Calgary PSIs 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 Calgary PSIs on the regional economy and the benefits generated by the institutions in return for the investments made by their key stakeholder groups: students, society, and taxpayers. Our approach is twofold. We begin with an economic impact analysis of Calgary PSIs on the regional business community in the Calgary Census Metropolitan Area. To derive results, we rely on Emsi's Canadian Regional Input-Output (CRIO) model to calculate the additional income created in the Calgary Census Metropolitan Area economy as a result of institution-linked input purchases, consumer spending, and the added skills of Calgary PSIs' students. Results of the regional economic impact analysis are broken out according to the following seven impacts: 1) impact of institutional operations, 2) impact of spending on research, 3) impact of start-up and spin-off companies, 4) impact of total factor productivity, 5) impact of student spending, 6) impact of visitor spending, and 7) impact of the skills acquired by alumni that are still active in the Calgary Census Metropolitan Area workforce.

The second component of the study is a standard investment analysis to determine how money spent on Calgary PSIs performs as an investment over time. The investors in this case are students, society, and taxpayers, all of whom pay a certain amount in costs to support the educational activities at Calgary PSIs. The students' investment consists of their out-of-pocket expenses and the opportunity cost of attending the institutions as opposed to working. Society invests in education by forgoing the services that it would have received had government not funded Calgary PSIs and the business output that it would have enjoyed had students been employed instead of studying. The benefits Calgary PSIs create also wouldn't be possible without donations,

1 This analysis covers the postsecondary institutions in Calgary. See Appendix 1 for a list of the institutions included in this study.

which allow them to provide education to more students and further benefit society. Provincial taxpayers contribute their investment through government funding.

In return for these investments, students receive a lifetime of higher earnings, society benefits from an enlarged economy, improved quality of life, and a reduced demand for social services, and taxpayers benefit 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 taxpayers 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 Fiscal Year (FY) 2014-15 academic and financial reports from the institutions, 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.

KEY FINDINGS

The results of this study show that Calgary PSIs have a significant positive impact on the business community in the regional economy and generate benefits in return for the investments made by their main stakeholder groups: students, society, and taxpayers. 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 the regional economy

- Calgary PSIs employed **10,221** full-time equivalent (FTE) employees in FY 2014-15. Payroll amounted to **$1.2 billion**, much of which was spent in the Calgary Census Metropolitan Area to purchase groceries, clothing, and other household goods and services. Calgary PSIs are themselves buyers of goods and services and spent **$849.9 million** to support their operations in FY 2014-15. The net impact of Calgary PSIs' payroll and expenses toward day-to-day operations (excluding research activities) in the Calgary Census Metropolitan Area was approximately **$1.6 billion** in added income in FY 2014-15. This is equivalent to creating **26,369** average-wage jobs.
- Research activities of Calgary PSIs impact the regional economy by employing people and making purchases for equipment, supplies, and services. They also facilitate new knowledge creation throughout the Calgary Census Metropolitan Area through inventions, patent applications, and licenses. Research spending of Calgary PSIs generates **$278.6 million** in added regional income for the Calgary Census Metropolitan Area economy. This is equivalent to creating **4,732** average-wage jobs.
- Calgary PSIs create exceptional environments that foster innovation and entrepreneurship, evidenced by the number of start-up and spin-off companies related to Calgary PSIs created in the region. In FY 2014-15, start-up and spin-off companies related to Calgary PSIs created **$50.5 million** in added regional income for the Calgary Census Metropolitan Area economy. This is equivalent to creating **858** average-wage jobs.
- The research spending impact and the impact from start-up and spin-off companies help demonstrate the impact from the research operations of the Calgary PSIs and touch upon the impacts created through the entrepreneurial and innovative activity stemming from the institutions. However, they do not fully capture the broader spillover effects that stem from the research at the institutions. To account for these spillover effects, we turn toward total factor productivity, which measures the portion of Gross Regional Product stemming from research. In FY 2014-15, the total factor productivity impact attributable to Calgary PSIs amounted to **$334.2 million** in added income, equivalent to **5,677** average-wage jobs.
- A total of **7,904** students, including international students, relocated to the Calgary Census Metropolitan

Area from outside the region to attend Calgary PSIs. In addition, some students are residents of the Calgary Census Metropolitan Area who would have left the region if not for the existence of Calgary PSIs. The money that these out-of-region and retained students spent at local businesses to buy books and supplies, purchase groceries, rent accommodation, pay for transport, attend sporting events, and so on is attributable to Calgary PSIs. These expenditures added approximately **$94.1 million** in income to the Calgary Census Metropolitan Area economy in FY 2014-15. This is equivalent to creating **1,599** average-wage jobs.

- Out-of-region visitors attracted to the Calgary Census Metropolitan Area for activities at Calgary PSIs brought new dollars to the economy through their spending at hotels, restaurants, gas stations, and other regional businesses. Visitor spending added approximately **$4.5 million** in regional income for the Calgary Census Metropolitan Area economy. This is equivalent to creating **77** average-wage jobs.
- Approximately **78%** of students who attended Calgary PSIs stay in the Calgary Census Metropolitan Area after leaving or graduating from the institutions. 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 students of Calgary PSIs who were employed in the regional workforce in FY 2014-15 amounted to **$6.3 billion** in added income in the Calgary Census Metropolitan Area economy. This is equivalent to creating **106,624** average-wage jobs.
- The total impact of Calgary PSIs on the regional business community in the Calgary Census Metropolitan Area in FY 2014-15 was **$8.6 billion** in added income. This is approximately equal to **7.0%** of the region's Gross Regional Product and **145,936** average-wage jobs.

Return on investment to students, society, and taxpayers

- Students paid a total of **$496.7 million** to cover the cost of tuition and fees and books and supplies at Calgary PSIs in FY 2014-15. They also forwent **$1.3 billion** in earnings that they would have generated had they been working instead of attending school.
- In return for the monies invested in Calgary PSIs, students receive a present value of **$5.5 billion** in increased earnings over their working lives. This translates to a return of **$3.10** in higher future earnings for every $1.00 that students pay for their education at Calgary PSIs. The corresponding internal rate of return is **13.5%**.
- Society as a whole in the province of Alberta will receive a present value of **$20.3 billion** in added provincial income over the course of the students' working lives. Society will also benefit from **$110.3 million** in present value social savings related to reduced crime, lower unemployment, and increased health and well-being across the province.
- For every $1.00 that society spent on educations at Calgary PSIs in FY 2014-15, society as a whole will receive a cumulative value of **$6.00** in benefits, for as long as the FY 2014-15 student population of Calgary PSIs remains active in the provincial workforce.
- Provincial taxpayers in Alberta paid **$993.7 million** to support the operations of Calgary PSIs in FY 2014-15. The net present value of the added tax revenue stemming from the students' higher lifetime earnings and the increased output of businesses amounts to **$3.5 billion** in benefits to taxpayers. Savings to the public sector add another **$42.3 million** in benefits due to a reduced demand for government-funded social services in Alberta.
- Dividing the benefits to provincial taxpayers by the amount that they paid to support Calgary PSIs yields a **3.5** benefit-cost ratio, i.e., every $1.00 in costs returns **$3.50** in benefits. In other words, taxpayers fully recover the cost of the original investment and also receive a return of **$2.50** in addition to every $1.00 they paid. The average annual internal rate of return for taxpayers is **17.6%**.

CHAPTER 1:

Profile of Calgary PSIs and the Regional Economy

The Calgary Census Metropolitan Area is home to a number of postsecondary education institutions, each with their own unique focus and their own impact on the economy and community of Calgary, Alberta, and Canada as a whole. The economic impact study specifically considers the economic benefits which seven of those institutions offer to the economy of the Calgary Census Metropolitan Area.

ABOUT CALGARY PSIS

Alberta College of Art and Design

The Alberta College of Art and Design (ACAD) is Alberta's only college focused exclusively on arts, crafts, and design, and has been serving Calgary since 1926. In FY 2014-15, ACAD enrolled around 1,190 credit and 50 non-credit students. These numbers represent a diverse student body that calls 30 countries home, and one that experiences a college with small classes (an average of 15 students per class).

ACAD offers bachelor's degrees in design and fine arts, with 11 specializations that include photography, visual communication design, ceramics, painting, print media, and more, as well as a master of fine arts in craft media with specializations in ceramics, fibre, glass, and jewellery and metals. ACAD is home to two primary galleries, the Illingsworth Kerr Gallery and the Marion Nicoll Gallery, as well as eight student-run galleries. In total, ACAD offers its students 293,000 square feet of studio spaces, not including designated home studios for third and fourth year students.

Ambrose University

Ambrose University (Ambrose) is a privately operated Christian liberal arts university formed from the merger of Alliance University College and Nazarene University College in 2007. These two institutions had previously served Calgary since 1941 and 1921, respectively. Ambrose is affiliated with the Church of the Nazarene and with the Christian and Missionary Alliance. In FY 2014-15, Ambrose was home to around 790 credit and 270 non-credit students.

Ambrose has three primary programs: Arts & Science, the School of Ministry, and the Seminary. The Arts & Science program offers bachelor's of arts degrees in a variety of disciplines, as well as bachelor's of science in business administration, music, and education, and a diploma in acting. The School of Ministry offers associate and bachelor's degrees in theology, while the seminary offers master of divinity and master of Christian studies degrees, an online- and classroom-blended master of arts, and is also home to a Chinese School of Theology.

Bow Valley College

As Alberta's largest community college, Bow Valley College has been dedicated to providing high quality lifelong learning opportunities in response to regional, community industry and learner demand since 1965. Operating in Calgary and throughout the surrounding region, Bow Valley College's multi-campus college provides broad programming, including certificates, diplomas, foundational learning and upgrading programs.

In FY 2014-15, Bow Valley College had an enrollment of around 11,780 credit and 3,020 non-credit students. Of those, 74% were from Calgary, while 8% were international students. Bow Valley College's learners have an opportunity to pursue over 70 career programs and 900 courses in partnership with eCampusAlberta. The College's program offerings range from business administration, health, human services, and justice studies, as well as English language learning, academic foundations and continuing education.

In addition to the College's commitment providing educational opportunities, Bow Valley College pursues applied research activities to enhance teaching and learning and foster innovation in support of industry sectors where the College's academic expertise enables a meaningful contribution.

Mount Royal University

Student surveys rank Mount Royal University among Canada's best universities for quality of teaching and overall educational experience. The University has carved out a distinct niche by offering undergraduate degrees that feature smaller class sizes, work placements that lead to jobs, and research opportunities. Nearly 12,000 credit students can choose among 12 bachelor degrees and 32 majors in unique and innovative areas, from aviation to midwifery, and from broadcasting to child studies. A University Entrance Option, as well as many certificate and diploma programs are also available.

The University constantly seeks ways to partner with and contribute to the community. As a national leader in community service learning, nearly 25 per cent of students provide close to 300,000 hours of community service annually. As well, the Lincoln Park campus is a welcoming place to learn, connect, live, work and grow. Calgarians are invited to come and take a wide range of non-credit courses, enjoy top-quality recreation facilities, see a performance at the Bella Concert Hall, book conference facilities and access Library resources. More than 90,000 Mount Royal alumni contribute to their communities around the world.

Southern Alberta Institute of Technology

The Southern Alberta Institute of Technology (SAIT) is a polytechnic institute that provides career-oriented programs related to business, trades, and technology. SAIT was established in 1916 as Canada's first publicly funded institute of its kind, and is the oldest post-secondary educator in Calgary. Today, in addition to its main campus in downtown Calgary, SAIT has three other campuses – Mayland Heights, the Art Smith Aero Centre at the Calgary International Airport, and the Culinary Campus.

In FY 2014-15, SAIT enrolled around 28,420 credit students and more than 22,370 non-credit students. The institute is comprised of eight schools, each with their own specialization, as well as two centres. Together, these schools and centres offer students a total of 84 daytime and 37 apprenticeship programs, including two bachelor's degrees, three applied degrees, 73 certificates and one-year diplomas, and numerous continuing education options, as well as customized training developed for local businesses. The practical aspect of the education SAIT offers is reflected in the fact that since 2009, it Applied Research and Innovation Services division has worked with industry partners to develop 425 prototypes.

St. Mary's University

St. Mary's University (St. Mary's) is a teaching and research liberal arts and sciences university. Originally established as a college in 1986, St. Mary's was accredited to grant degrees in 2004. St. Mary's is a fully accredited Catholic university with a FY 2014-15 enrolment of around 790 credit and 170 non-credit students. St. Mary's is located on a historic campus adjacent to Fish Creek Provincial Park. The campus incorporates several provincially-designated Heritage Buildings.

St. Mary's students pursue bachelor's degrees in arts, sciences, and education, including four 3-year degrees, five 4-year degrees and an Education after-degree program. St. Mary's also provides transferable university courses in a total of 35 academic disciplines. St. Mary's students enjoy small class sizes and opportunities to work directly with professors in the classroom, the lab and the field. There are also non-credit programs including Catholic Educational Leadership, the Sacred Arts Certificate, and the Humanities 101 program that provides post-secondary learning opportunities to Calgary's least fortunate citizens.

University of Calgary

The University of Calgary (UCalgary) is a public research university with four campuses across the Calgary Census Metropolitan Area (and a fifth location in Doha, Qatar). Granted autonomy as a university in 1966 (but with origins in the early 1900s), UCalgary enrolled around 32,520 for-credit and 12,030 non-credit students in undergraduate, graduate and professional degree programs in FY 2014-15. Two-thirds of the university's 163,000 alumni live and work in the Calgary Census Metropolitan Area.

UCalgary has 14 faculties offering more than 250 academic programs, and more than 50 research institutes and centres. In addition to the faculties of Arts, Science, Kinesiology, and Graduate Studies, professional schools include the Haskayne School of Business, the Schulich School of Engineering, the Cumming School of Medicine, the Faculty of Law, the Faculty of Environmental Design, the Werklund School of Education, the Faculty of Social Work, the Faculty of Nursing and the Faculty of Veterinary Medicine. UCalgary encourages multi-disciplinary programs as well as international study, volunteer, work, and research programs that provide global context while promoting diversity and excellence in learning.

UCalgary is one of Canada's leading research institutions, with critical mass of expertise in six thematic areas: energy innovations; brain and mental health; biomedical engineering; infections, inflammations and chronic diseases; new Earth-space technologies; and human dynamics in a changing world.

In 2016, UCalgary was ranked as the top university under the age of 50 in both Canada and North America by the Times Higher Education World University Rankings, and as one of the top 200 universities in the world by QS World University Rankings and Times Higher Education World University Rankings.

INTERNATIONAL CONNECTIONS AT CALGARY PSIS

While the primary impacts which Calgary PSIs have is on their immediate community (whether that community is considered as the city, the province, or Canada as a whole), the benefits which they provide are not confined by borders. Instead, they have a wide variety of international connections that extend their connections around the world.

In the analysis year, the institutions participating in this study reported that they enrolled thousands of students from outside of Canada. Taken in tandem with the exchange arrangements by which students from several of the schools, including MRU, Bow Valley College, SAIT, and UCalgary, have earned part of their degree abroad, and with programs by which faculty also perform research and do teaching in other countries, these connections give Calgary PSIs the capacity to not only bring outside talent into the Calgary Census Metropolitan Area, whether temporarily or permanently, but also the ability to send their expertise around the world.

SAIT currently has partnerships and arrangements with numerous international schools and organizations, including the development of an operations technician program in Queensland, providing guidance to Kazakhstan's Atyrau Oil and Gas Training Center in organizing training for its facilities, and establishing curriculum licensing arrangements with numerous partners.

Bow Valley College not only participates in international student recruitment fairs and scholarship programs, but it also has a variety of active international projects. Those projects include activity in Tanzania, Belize, and St. Vincent and the Grenadines. Similarly, St. Mary's is also expanding its international initiatives to include study exchange agreements with institutions in the Ukraine, Germany, Taiwan, and Zambia.

MRU has numerous international partnerships, including opportunities for semester or full year exchanges at foreign institutions and employment or internship in international programs. Its international programs give students the chance, not only to study abroad, but also to participate in international field schools and development projects, and to share expertise with associates in developing countries that help not only them but also their partners establish increased capacity.

The students, staff and faculty of the University of Calgary are engaged in a wide range of international activity, producing graduates with global knowledge, forging strategic alliances, and promoting diversity and innovation in teaching and research. Not only does the university operate an international campus in Qatar (focused on nursing), but it also sustains more than 250 collaboration agreements with partner universities in 140 countries. In addition to nearly 3,500 international students who have come to Calgary, 1,100 students are studying in 80+ destinations worldwide through the Study Abroad program. The university has more than 115 active projects in research,education, and service in 76 different countries — more than half of these involving students. UCalgary alumni are represented in more than 150 countries around the world.

EMPLOYEE AND FINANCE DATA

Estimating the economic value of Calgary PSIs requires three types of information: (1) employee and finance data, (2) student demographic and achievement data, and (3) the economic profile of the region. All data reflects Fiscal Year (FY) 2014-15. For the purpose of this study, information on the institutions and their students and visitors was obtained from Calgary PSIs, and data on the regional economy were drawn from Emsi's proprietary data modeling tools.

Employee data

Data provided by Calgary PSIs include information on institutions' employees by place of work and by place of residence. These data appear in Table 1.1. As shown, 10,221 full-time equivalent employees worked at Calgary PSIs in FY 2014-15. Of these, almost 100% worked in the Calgary Census Metropolitan Area and 96% lived in the region. These data are used to isolate the portion of the employees' household expenses that remains in the regional economy.

Revenues

Table 1.2 shows Calgary PSIs' annual revenues by funding source—a total of $2.2 billion in FY 2014-15. As indicated, tuition and mandatory fees comprised 20.2% of total revenue, revenue from regional grants and contract 45.6%, revenue from federal grants and contracts 5.1%, and all other non-government revenue (i.e., sales, donations, and non-government grants and contracts) the remaining 29.0%. These data are critical in identifying annual costs of educating the institutions' students from the perspectives of students and taxpayers.

Expenditures

Calgary PSIs' combined payroll amounted to $1.2 billion, equal to 57.9% of the institutions' total expenses for FY 2014-15. Other expenditures, including capital and purchases of supplies and services, made up $849.9 million. These budget data appear in Table 1.3.

TABLE 1.1: Employee data, FY 2014-15

Total full-time equivalent employees	**10,221**
% of employees that work in region	100%
% of employees that live in region	96%

Source: Data supplied by Calgary PSIs.

TABLE 1.2: Revenue by source, FY 2014-15

FUNDING SOURCE	TOTAL	% OF TOTAL
Tuition and mandatory fees	$440,810,151	20.2%
Provincial grants and contracts	$993,683,605	45.6%
Federal grants and contracts	$111,542,125	5.1%
Other non-government revenue	$630,889,295	29.0%
Total revenues	**$2,176,925,176**	**100.0%**

Source: Data supplied by Calgary PSIs.

TABLE 1.3: Expenses by function, FY 2014-15

EXPENSE ITEM	TOTAL	%
Salaries and benefits	$1,170,063,847	57.9%
Amortization of property and equipment	$68,813,191	3.4%
All other expenditures	$781,061,937	38.7%
Total expenses	**$2,019,938,975**	**100.0%**

Source: Data supplied by Calgary PSIs.

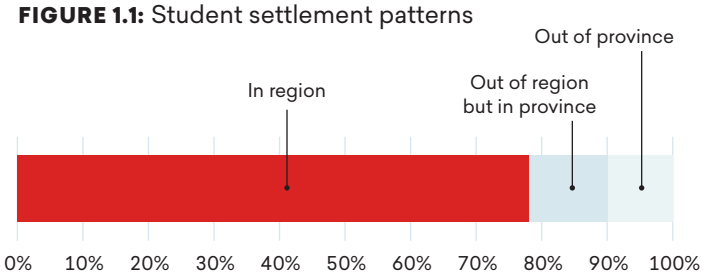
STUDENT PROFILE DATA

Demographics

Calgary PSIs served 87,783 credit students and 39,937 non-credit students in the 2014-15 reporting year. The breakdown of the student body by gender was 50% male and 50% female. The students' overall average age was 27 years old.

Figure 1.1, on the next page, presents the settlement patterns of Calgary PSIs' students after exiting the institutions. As indicated, 78% of students remain in the Calgary Census Metropolitan Area, 12% remain in Alberta but outside the region, and the remaining 10% settle outside the region.

FIGURE 1.1: Student settlement patterns



Achievements

Table 1.4 summarizes the breakdown of the student population by credential type and the corresponding number of full-load equivalents (FLEs). FLEs are used to standardize actual course loads against normal course loads in order to combine full-time and part-time student counts. FLE 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, Calgary PSIs served 1,948 doctoral students, 4,354 master's degree students, and 36,438 bachelor's degree students. Calgary PSIs also served 14,960 diploma students, 11,282 certificate students, and 8,258 apprenticeship students. Another 5,964 students pursued developmental credentials, such as the high school diploma or ESL certificate.

A total of 26,148 students enrolled in personal enrichment programs or courses. In the analysis, we exclude personal enrichment students and their corresponding FLE 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 18,368 students.

Altogether, Calgary PSIs served 127,720 students and issued 17,517 credentials during the analysis year. The total FLE production for the student population (excluding personal enrichment students) was 58,834 FLEs, for an overall average of 0.58 FLEs per student.

TABLE 1.4: Breakdown of student population by credential type, FY 2014-15

CATEGORY	HEADCOUNT	FLES	AVERAGE FLES PER STUDENT	NUMBER OF CREDENTIALS ISSUED
Doctorate degree	1,948	1,809	0.93	279
Master's degree	4,354	3,592	0.83	1,319
Bachelor's degree	36,438	29,340	0.81	7,235
Diploma	14,960	10,384	0.69	4,034
Certificate	11,282	3,708	0.33	2,682
Apprenticeship	8,258	2,384	0.29	1,950
Developmental	5,964	2,723	0.46	0
Personal enrichment	26,148	2,080	0.08	0
All other	18,368	4,893	0.27	18
Total, all students	**127,720**	**60,914**	**0.48**	**17,517**
Total, less personal enrichment	**101,572**	**58,834**	**0.58**	**17,517**

Source: Data supplied by Calgary PSIs. Estimate of FLEs for "All Other" students provided by Emsi.

REGIONAL PROFILE DATA

Gross Regional Product

Table 1.5 summarizes the breakdown of the Calgary Census Metropolitan Area economy by major industrial sector, with details on labour income, non-labour income, and total income, also referred to as Gross Regional Product (GRP). Labour income includes the wages and salaries of employees (excluding self-proprietors), and non-labour income includes operating surplus, mixed income, and taxes less subsidies on production, products and imports. Together labour income and non-labour 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 institutions on economic growth in the region. As shown in Table 1.5, total GRP in the Calgary Census Metropolitan Area is approximately $123.6 billion, equal to $39.4 billion in earnings plus $84.2 billion in other income.

TABLE 1.5: Earnings, other income, and Gross Regional Product (GRP) by major industrial sector in the Calgary Census Metropolitan Area, 2014-15

INDUSTRY SECTOR	EARNINGS (MILLIONS)	OTHER INCOME (MILLIONS)	TOTAL GRP (MILLIONS)	% OF TOTAL
Agriculture, forestry, fishing and hunting	$101	$431	$531	0.4%
Mining, quarrying, and oil and gas extraction	$5,289	$44,872	$50,161	40.6%
Utilities	$736	$1,694	$2,430	2.0%
Construction	$3,414	$4,045	$7,459	6.0%
Manufacturing	$2,810	$3,695	$6,505	5.3%
Wholesale trade	$2,337	$2,453	$4,790	3.9%
Retail trade	$2,236	$1,461	$3,698	3.0%
Transportation and warehousing	$2,213	$5,305	$7,518	6.1%
Information and cultural industries	$965	$1,618	$2,583	2.1%
Finance and insurance	$1,657	$2,856	$4,513	3.7%
Real estate and rental and leasing	$792	$4,597	$5,389	4.4%
Professional, scientific, and technical services	$5,055	$4,287	$9,342	7.6%
Management of companies and enterprises	$1,029	$373	$1,402	1.1%
Administrative and support, waste management and remediation services	$1,750	$738	$2,488	2.0%
Educational services	$2,084	$985	$3,069	2.5%
Health care and social assistance	$2,524	$1,166	$3,690	3.0%
Arts, entertainment, and recreation	$376	$262	$638	0.5%
Accommodation and food services	$1,046	$559	$1,605	1.3%
Other services (except public administration)	$1,139	$910	$2,050	1.7%
Public administration	$1,839	$1,882	$3,721	3.0%
Total	**$39,391**	**$84,189**	**$123,579**	**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.

Jobs by industry

Table 1.6, provides the breakdown of jobs by industry in the Calgary Census Metropolitan Area. The "Professional, scientific, and technical services" industry is the region's largest employer, supporting 89,657 jobs or 11.6% of total employment. The second largest employer is the "Retail trade" industry, supporting 81,922 jobs or 10.6% of total employment. Altogether, the region supports 773,646 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 Calgary Census Metropolitan Area, 2014-15

INDUSTRY SECTOR	TOTAL JOBS	% OF TOTAL
Agriculture, forestry, fishing and hunting	4,659	0.6%
Mining, quarrying, and oil and gas extraction	45,785	5.9%
Utilities	6,650	0.9%
Construction	71,176	9.2%
Manufacturing	46,427	6.0%
Wholesale trade	35,700	4.6%
Retail trade	81,922	10.6%
Transportation and warehousing	43,954	5.7%
Information and cultural industries	15,250	2.0%
Finance and insurance	28,446	3.7%
Real estate and rental and leasing	18,963	2.5%
Professional, scientific, and technical services	89,657	11.6%
Management of companies and enterprises	9,638	1.2%
Administrative and support, waste management and remediation services	42,128	5.4%
Educational services	40,507	5.2%
Health care and social assistance	62,460	8.1%
Arts, entertainment, and recreation	15,515	2.0%
Accommodation and food services	48,934	6.3%
Other services (except public administration)	37,876	4.9%
Public administration	27,998	3.6%
Total	**773,646**	**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.

Earnings by education level

Table 1.7 and Figure 1.2, on the next page, present the average earnings by education level in the Calgary Census Metropolitan Area 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 Calgary Census Metropolitan Area.

As shown, students who achieve a bachelor's degree can expect $62,300 in earnings per year, approximately $29,700 more than someone with a high school diploma. The difference between a high school diploma and the attainment of a post bachelor's degree is even greater – up to $41,300 in higher income.

TABLE 1.7: Expected earnings in the Calgary Census Metropolitan Area at midpoint of individual's working career by education level

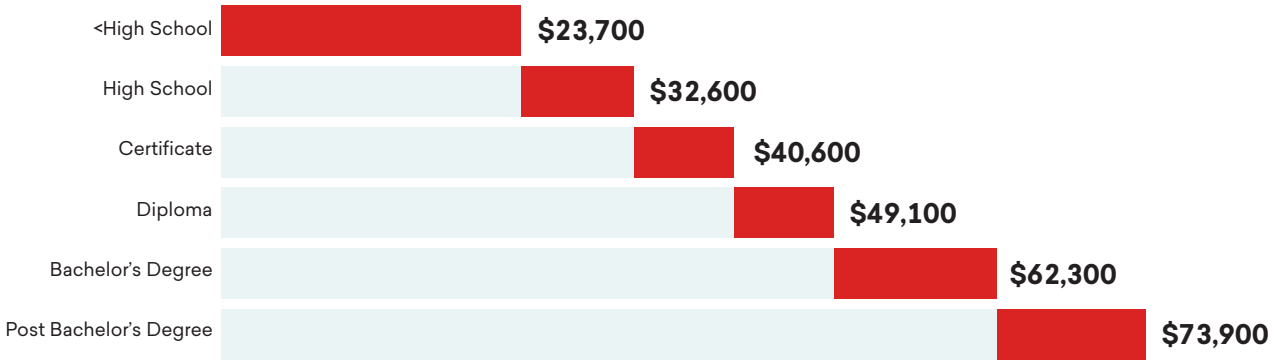
EDUCATION LEVEL	INCOME	DIFFERENCE
Less than high school	$23,700	n/a
High school or equivalent	$32,600	$8,900
Certificate	$40,600	$8,000
Diploma	$49,100	$8,500
Bachelor's degree	$62,300	$13,200
Post bachelor's degree	$73,900	$11,600

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

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 Calgary PSIs' impact on the regional economy, and Chapter 3 looks at Calgary PSIs as an investment. The appendices detail a collection of miscellaneous theory and data issues.

FIGURE 1.2: Expected income by education level at career midpoint



CHAPTER 2:

Economic Impact Analysis

The Calgary Census Metropolitan Area economy is impacted by Calgary PSIs in a variety of ways. The institutions are employers and buyers of goods and services. They attract monies that would not have otherwise entered the regional economy through their day-to-day operations, their research activities, and the expenditures of their out-of-region students and visitors. Further, they foster the development of new start-up and spin-off companies and other spillover effects, as well as provide students with the knowledge, skills, and abilities they need to become productive citizens and contribute to the overall output of the region.

This section presents the total economic impact of Calgary PSIs broken out according to the following categories:

- Impact of **spending for institutional operations**
- Impact of **spending on research and development**
- Impact of **start-up and spin-off companies**
- Impact of **total factor productivity**
- Impact of **student spending**
- Impact of **visitor spending**
- Impact of **former students** employed in the Calgary Census Metropolitan Area workforce.

Economic impact analyses use different types of impacts to estimate the results. Frequently used is the **sales** impact, which comprises the change in business sales revenue in the economy as a result of increased economic activity. However, much of this sales revenue leaves the economy and overstates actual impacts. A more conservative measure – and the one employed in this study – is the **income impact**, which assesses the change in gross regional product, or GRP. Income may be further broken out into the **labour income impact**, which assesses the change in employee compensation; and the **non-labour income impact**, which assesses the change in income business profits. Another way to state the income impact is **job equivalents**, a measure of the number of average-wage jobs that would be required to support the change in income. All of these measures – job equivalents, income with labour income and non-labour income detail, and sales – are used to estimate the economic impact results presented in this section.

The analysis breaks out the impact measures into different components, each based on the economic effect that caused the impact. The following is a list of each type of effect presented in this analysis:

- The **initial effect** is the exogenous shock to the economy caused by the initial spending of money, whether to pay for salaries and wages, purchase goods or services, or cover operating expenses.
- The initial round of spending creates more spending in the economy, resulting in what is commonly known as the **multiplier effect**. The multiplier effect comprises the additional activity that occurs across all industries in the economy and may be further decomposed into the following three types of effects:
    - The **direct effect** refers to the additional economic activity that occurs as the industries affected by the initial effect spend money to purchase goods and services from their supply chain industries.
    - The **indirect effect** occurs as the supply chain of

the initial industries creates even more activity in the economy through their own inter-industry spending.

- The **induced effect** refers to the economic activity created by the household sector as the businesses affected by the initial, direct, and indirect effects raise salaries or hire more people.

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 304 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 5.

INSTITUTIONAL OPERATIONS SPENDING IMPACT

Most of Calgary PSIs' employees live in the Calgary Census Metropolitan Area (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, Calgary PSIs are also purchasers of supplies and services. Many of Calgary PSIs' vendors are located in the Calgary Census Metropolitan Area, creating a ripple effect that generates still more jobs and income throughout the economy. Table 2.1 presents the economic impact of Calgary PSIs operations. Note these impacts do not include impacts from Calgary PSIs' research activities, which are presented separately in the next section.

Table 1.3 in Chapter 1 breaks Calgary PSIs' expenditures into the following three categories: payroll, capital depreciation, and all other expenditures (including purchases for supplies and services).[3] The first step in estimating the multiplier effect of these expenditures is to map them individually to the 304 industry sectors of the Emsi CRIO model. Assuming that the spending patterns of institution personnel approximately match those of the average consumer, we map institution salaries and benefits 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., amortization of property and equipment and all other expenditures), we again assume that the institutions' spending patterns approximately match national averages and apply the national spending coefficients for the "Educational services (Universities)" industry sector (NAICS 6113). Amortization of property and equipment is mapped to the construction sectors of NAICS 6113 and the institutions' remaining expenditures to the non-construction sectors of NAICS 6113.

3 Table 1.3 includes all institutional expenditures, including those for research activities. In the institutional operations spending impact, research expenditures are separated out and instead included in the following section.

TABLE 2.1: Institutional operations spending impact (excluding research activities), FY 2014-15

	LABOUR INCOME (THOUSANDS)	NON-LABOUR INCOME (THOUSANDS)	TOTAL INCOME (THOUSANDS)	SALES
Initial effect	**$1,014,704**	**$0**	**$1,014,704**	**$1,697,659**
MULTIPLIER EFFECT				
Direct effect	$113,023	$115,556	$228,579	$473,879
Indirect effect	$37,977	$38,467	$76,444	$170,616
Induced effect	$224,173	$247,214	$471,387	$967,287
Total multiplier effect	**$375,174**	**$401,236**	**$776,410**	**$1,611,781**
Gross impact (initial + multiplier)	**$1,389,878**	**$401,236**	**$1,791,114**	**$3,309,440**
Less alternative uses of funds	-$110,726	-$128,068	-$238,794	-$498,240
Net impact	**$1,279,152**	**$273,168**	**$1,552,321**	**$2,811,201**

Source: Emsi CRIO model.

We now have three vectors detailing the spending of Calgary PSIs: one for institution payroll, another for capital items, and a third for Calgary PSIs' 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 304 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 regional suppliers. For example, if 40% of the demand for NAICS 52410 ("Insurance carriers") is satisfied by regional 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 institution spending vectors are thus multiplied sector-by-sector by the corresponding RPC for each sector to arrive at the strictly regional spending associated with the institutions.

Regional 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 labelled "Multiplier effect" in Table 2.1. Altogether, Calgary PSIs' spending creates $375.2 million in earnings and another $401.2 million in other income through multiplier effects—a total of $776.4 million. This together with the $1 billion in initial effects generates a gross total of $1.8 billion in impacts associated with the spending of Calgary PSIs and their employees in the region.

Here we make a significant qualification. Calgary PSIs received an estimated 33.8% of their funding from sources in the Calgary Census Metropolitan Area. These monies came from students living in the region, from private sources, and from the local share of provincial taxes.[4] Had other industries received these monies rather than Calgary PSIs, 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 Calgary PSIs– 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 Calgary PSIs, we calculate counterfactual outcomes by modeling the local monies spent on the institutions as regular spending on consumer goods and savings. Our assumption is that, had students not spent money on the institutions, they would have used that money instead to buy consumer goods. Similarly, had the monies that taxpayers spent on Calgary PSIs 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 Calgary PSIs, 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 regional 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 labelled "Less alternative uses of funds" in Table 2.1.

The net total income impact of Calgary PSIs spending can now be computed. As shown in the last row of Table 2.1, the net impact is approximately $1.3 billion in earnings and $273.2 million in other income. The overall total is $1.6 billion, representing the added income created in the regional economy as a result of Calgary PSIs operations. This is equivalent to 26,369 average-wage jobs.

RESEARCH SPENDING IMPACT

Similar to the day-to-day operations of Calgary PSIs, research activities impact the economy by employing people and requiring the purchase of equipment and other supplies and services. The institutions provided their research expenses by function – payroll, materials and supplies, equipment, and all other research expenses and fees such as those for travel and professional fees – for the last four fiscal years.[5] As seen in Table 2.2 on the next page, Calgary PSIs spent over $322.3 million on research and development

4 Local taxpayers pay provincial taxes, and it is thereby fair to assume that a portion of the provincial funds received by Calgary PSIs 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.

5 For confidentiality purposes, Table 2.2 (on the next page) displays only total research expenses.

activities in FY 2014-15. These expenses would not have been possible without funding from outside the region – Calgary PSIs received around 27% of their research funding from federal and other sources.

We employ a methodology similar to the one used to estimate the impacts of operational expenses. We begin by mapping research expenses by function to the relevant industries of the CRIO model, removing the spending that occurs outside the region, and then running the in-region expenses through the multiplier matrix. As with the operations spending impact, we also adjust the gross impacts to account for the opportunity cost of monies withdrawn from the regional economy to support the research of Calgary PSIs, whether through regional-sponsored research awards or through private donations. Again, we refer to this adjustment as the alternative use of funds.

Initial, direct, indirect, and induced effects of Calgary PSIs' research expenses appear in Table 2.3. The institutions' research expenses have a total gross impact of $220.5 million in labour income and $94.3 million in non-labour income. This totals $314.8 million in total added income. Taking into account the effect of the alternative uses of funds, net research expenditure impacts of Calgary PSIs are $203.7 million in labour income and $74.9 million in non-labour income, totaling $278.6 million in total added income. This is equivalent to 4,732 average-wage jobs.

Research and innovation play an important role in driving the Calgary Census Metropolitan Area economy. Some indicators of innovation are the number of research publications, invention disclosures, and license agreements.

TABLE 2.2: Research expenses by function of Calgary PSIs, FY 2014-15

FISCAL YEAR	TOTAL (THOUSANDS)
2014-15	$322,279
2013-14	$306,526
2012-13	$290,616
2011-12	$266,119

Source: Data supplied by Calgary PSIs.

TABLE 2.3: Calgary PSIs research spending impacts, FY 2014-15

	LABOUR INCOME (THOUSANDS)	NON-LABOUR INCOME (THOUSANDS)	TOTAL INCOME (THOUSANDS)	SALES
Initial effect	**$150,749**	**$0**	**$150,749**	**$322,279**
MULTIPLIER EFFECT				
Direct effect	$25,433	$37,949	$63,381	$128,487
Indirect effect	$8,391	$12,627	$21,019	$43,212
Induced effect	$35,914	$43,736	$79,650	$161,988
Total multiplier effect	**$69,738**	**$94,312**	**$164,050**	**$333,688**
Gross impact (initial + multiplier)	**$220,487**	**$94,312**	**$314,799**	**$655,968**
Less alternative uses of funds	-$16,790	-$19,420	-$36,210	-$75,551
Net impact	**$203,697**	**$74,893**	**$278,590**	**$580,416**

Source: Emsi CRIO model.

TABLE 2.4: Research publications, invention disclosures, licenses, and license income of Calgary PSIs

FISCAL YEAR	RESEARCH PUBLICATIONS	INVENTION DISCLOSURES RECEIVED	LICENSES AGREEMENTS	ADJUSTED GROSS LICENSE INCOME
2014-15	5,114	113	21	$300,000
2013-14	5,422	124	15	$518,000
2012-13	5,208	61	5	$563,000
2011-12	4,481	77	4	$537,000
Total	**20,225**	**375**	**45**	**$1,918,000**

Source: Data supplied by Calgary PSIs.

Over the last four years, Calgary PSIs published 20,225 research articles, received 375 invention disclosures, and produced 45 licenses (see Table 2.4, on the previous page). Without the research activities of Calgary PSIs, this level of innovation and sustained economic growth would not have been possible.

IMPACT OF START-UP AND SPIN-OFF COMPANIES

This subsection presents the economic impact of companies that would not have existed in the region but for the presence of Calgary PSIs. To estimate these impacts, we categorize companies according to the following types:

- **Start-up companies:** Companies created specifically to license and commercialize technology or knowledge of Calgary PSIs.
- **Spin-off companies:** Companies created and fostered through programs offered by Calgary PSIs that support entrepreneurial business development, or companies that were created by faculty, students, or alumni as a result of their experience at Calgary PSIs.

We vary our methodology from the previous sections in order to estimate the impacts of start-up and spin-off companies. Ideally, we would use detailed financial information for all start-up and spin-off companies to estimate their impacts. However, collecting that information is not feasible and would raise a number of privacy concerns. As an alternative, we use the number of employees of each start-up and spin-off company that were collected and reported by Calgary PSIs. Table 2.5 presents the list of start-up and spin-off companies related to Calgary PSIs and their aggregated number of employees that were active in the Calgary Census Metropolitan Area during the analysis year.[6]

First, we match each start-up and spin-off company with the closest NAICS industry. Next, we assume the companies have earnings and spending patterns – or production functions – similar to their respective industry averages. Given the number of employees reported for each company, we use industry-specific jobs-to-earnings and earnings-to-sales ratios to estimate the sales of each business. Once we

6 The number of start-up and spin-off companies and their employees may be significantly undercounted due to the lack of available data.

TABLE 2.5: Start-up and spin-off companies related to Calgary PSIs that were active in the Calgary Census Metropolitan Area in FY 2014-15

	NUMBER OF COMPANIES	NUMBER OF EMPLOYEES
Start-up companies	22	111
Alberta Biophotonics Inc.		
Ammolite BioModels Inc.		
Arch Biopartners Inc.		
Bow Valley Innovations Inc.		
Carbon Engineering Ltd.		
Circle Cardiovascular Imaging Inc.		
Direct-C		
Diversity Leads		
Epimeron		
Firewater Fuel Corp.		
FREDsense Technologies Corp.		
iKingdom Corp.		
iMirror		
nFluids		
Oncolytics Inc.		
Parvus Therapeutics Inc.		
Roscol Technologies		
RxRobots Inc.		
Savvy Knowledge Corp.		
Soleromed Inc.		
Spotcast		
ZST Holdings Inc.		
Spin-off companies	17	40
Azra Images		
Beauty Butlers		
Deepwater Farms		
GNS3		
Green Cup		
Hyperheat Technologies		
Incite Invite		
Local Laundry		
NiteBite		
Nomad Eco Products		
Novo Ideation		
Smokebarrel		
SWAY Marketing		
The Well Brewery		
TikTiks		
TLink Golf		
Trout & Taylor		

Source: Data supplied by Calgary PSIs.

TABLE 2.6: Impact of start-up companies related to Calgary PSIs, FY 2014-15

	LABOUR INCOME (THOUSANDS)	NON-LABOUR INCOME (THOUSANDS)	TOTAL INCOME (THOUSANDS)	SALES
Initial effect	**$9,898**	**$14,021**	**$23,919**	**$55,394**
MULTIPLIER EFFECT				
Direct effect	$2,389	$3,546	$5,934	$12,112
Indirect effect	$779	$1,163	$1,942	$3,915
Induced effect	$3,573	$4,836	$8,409	$16,179
Total multiplier effect	**$6,741**	**$9,544**	**$16,285**	**$32,206**
Total impact (initial + multiplier)	**$16,639**	**$23,565**	**$40,204**	**$87,600**

Source: Emsi CRIO model.

have the sales estimates, we follow a similar methodology as outlined in the previous sections by running sales through the CRIO to generate the direct, indirect, and induced multiplier effects.

Table 2.6 presents the impacts of the start-up companies. The initial effect is the 111 jobs, equal to the number of employees at all Calgary PSIs start-up companies in the region (from Table 2.5). The corresponding initial effect on labour income is $9.9 million. The total impacts (the sum of the initial, direct, indirect, and induced effects) are $16.6 million in added labour income and $23.6 million in non-labour income, totaling $40.2 million in total added income. This is equivalent to 683 average-wage jobs.

Note that start-up companies have a strong and clearly defined link to Calgary PSIs. The link between the institutions and the existence of their spin-off companies, however, is less direct and is thus viewed as more subjective. For this reason, their impacts are estimated separately from the start-up companies. This way, while they are included in the grand total impact presented later in this report, a reader can separate them if preferred.[7]

As demonstrated in Table 2.7, Calgary PSIs create exceptional environments that foster innovation and entrepreneurship. As a result, the impacts of spin-off companies related to Calgary PSIs are $4.2 million in added labour income and $6.1 million in non-labour income, totaling $10.3 million in total added income. This is equivalent to 175 average-wage jobs.

7 The readers are ultimately responsible for making their own judgment on the veracity of the linkages between spin-off companies and Calgary PSIs. At the very least, the impacts of the spin-off businesses provide important context for the broader effects of Calgary PSIs. As such, we combine them with the impacts of the start-up businesses when calculating total impacts.

TABLE 2.7: Impact of spin-off companies related to Calgary PSIs, FY 2014-15

	LABOUR INCOME (THOUSANDS)	NON-LABOUR INCOME (THOUSANDS)	TOTAL INCOME (THOUSANDS)	SALES
Initial effect	**$2,599**	**$3,730**	**$6,329**	**$27,527**
MULTIPLIER EFFECT				
Direct effect	$632	$958	$1,590	$4,732
Indirect effect	$215	$342	$557	$1,592
Induced effect	$760	$1,038	$1,798	$4,573
Total multiplier effect	**$1,608**	**$2,338**	**$3,946**	**$10,897**
Total impact (initial + multiplier)	**$4,206**	**$6,068**	**$10,275**	**$38,424**

Source: Emsi CRIO model.

TOTAL FACTOR PRODUCTIVITY IMPACT

The research spending impact and the impact from start-up and spin-off companies help demonstrate the impact from the research operations of Calgary PSIs and touch upon the impacts created through the entrepreneurial and innovative activity stemming from the institutions. However, they do not fully capture the broader spillover effects that stem from the research at the institutions. This can include but is not limited to impacts from other businesses not captured within the start-up and spin-off impacts, business efficiencies from the creation of new technology, and medical breakthroughs for healthier and therefore more productive citizens.

To account for these spillover effects, we turn toward total factor productivity, which measures the portion of GRP stemming from research and development. According to neoclassical economic development theory, a region's GRP is dependent upon its inputs of labour and capital and how they are utilized in production. This is demonstrated by and is synonymous with the labour effect and non-labour effect, respectively, discussed in the previous impacts.

However, not all of a region's GRP can be linked to the utilization of labour and capital. This introduces the role of technology, developed through research and development, that results in the more efficient use of labour and capital, helping regions grow at a faster rate. This more efficient use of inputs is what we refer to as total factor productivity. Currently, linking total factor productivity growth to innovation sheds light on how research and the abundance of skilled labour reduces the marginal cost of research and increases the rate of innovation development and, therefore, the total factor productivity growth rate. Calgary PSIs – producing both research and skilled labour – are responsible for a portion of the total factor productivity growth, and it is this portion that creates an impact on the Calgary Census Metropolitan Area.

In order to calculate the total factor productivity impact, we rely upon methodology developed by Fernand Martin.[8] We begin by calculating the stock of labour and capital in Alberta. We collected data from 1981 to 2015 on the population aged 15 to 64, total employment, gross provincial product (GPP), and gross fixed capital accumulation. With this time series in place, we calculated the total factor productivity rate as 32%. In other words, total factor productivity accounted for 32% of growth in the GPP. The growth in GPP itself amounted to $195.1 billion from 1981 to 2015.

TABLE 2.8: Methodology for calculating total factor productivity attributable to Calgary PSIs (thousands)

Growth in GPP from 1981 to 2015	$195,136,000
Growth in GRP from 1981 to 2015 (44%)	$86,230,397
Average annual GRP growth	$2,536,188
Regional total factor productivity (32%)	**$823,787**
Domestic research and development (98%)	$810,202
Share of domestic research and development by Calgary PSIs (76%)	$612,775
Less research spending impact	-$278,590
Net total factor productivity impact of Calgary PSIs	**$334,185**

Source: Emsi impact model.

Note, however, that the $195.1 billion in GPP growth is at the provincial level. To regionalize the GPP growth, we look at the proportion of Calgary Census Metropolitan Area GRP compared to Alberta's GPP. We find the regional GRP comprises around 44% of the GPP, or that the Calgary GRP growth from 1981 to 2015 amounts to $86.2 billion.

We also need to make an adjustment to annualize the growth in GRP. The $86.2 billion represents the GRP growth from 1981 to 2015. However, for this impact, we want to measure the annual impact stemming from total factor productivity. In order to annualize the GRP growth, we divide the $86.2 billion by the number of years represented in the growth. This provides us with the average annual GRP growth, which takes into consideration external factors such as global market fluctuations, of $2.5 billion. Given data limitations, we assume that the proportion of growth due to total factor productivity (32%) is the same at the regional level as it is at the provincial level. Multiplying this 32% by the annual GRP growth provides us with a total factor productivity of $823.8 million for the Calgary Census Metropolitan Area, as seen in the fourth row of Table 2.8.

The $823.8 million in total factor productivity is the result

8 See Martin, 1998. Methodology was also based upon research performed by the University of Calgary, which used Martin's research.

TABLE 2.9: Total factor productivity impact of Calgary PSIs, FY 2014-15

	LABOUR INCOME (THOUSANDS)	NON-LABOUR INCOME (THOUSANDS)	TOTAL INCOME (THOUSANDS)	SALES
Total net impact	**$194,588**	**$139,597**	**$334,185**	**$632,325**

Source: Emsi impact model.

of all research activities, including those from private businesses, government entities, foreign sources, and PSIs. For this impact, we are concerned only with the research activities directly related to Calgary PSIs and therefore total factor productivity from Calgary PSIs. To arrive at this net impact, we first net out research from foreign sources. According to a report published by Statistics Canada, around 2% of research activity stemmed from foreign sources.[9] We therefore only account for 98% of the $823.8 million in annual total factor productivity, arriving at $810.2 million.

Next we must separate out the domestic research attributable to Calgary PSIs since the $810.2 million still includes businesses and government entities. As discussed in Section 2.2, Calgary PSIs spent $322.3 million on research activities. Lacking information on how much private and government enterprises spent on research, we rely on data within the Emsi CRIO model on the amount of sales for the "Scientific research and developmental services industry sector" (NAICS 5417). This provides us with $426.1 million in total industry sales. With this total in place, we calculate the proportion of total research spending attributable to Calgary PSIs as 76%. In other words, we now know that of the $810.2 million in domestic annual total factor productivity, $612.8 million can be attributed to Calgary PSIs.

Finally, we net out the research spending impact. Recall from Section 2.2 that we have already considered the impact generated by Calgary PSIs' research spending ($278.6 million). This impact is already accounted for in the $612.8 million in gross total factor productivity.

After subtracting out the research spending impact, we arrive at a net total factor productivity impact from Calgary PSIs of $334.2 million. This represents an annual impact and is equivalent to 5,677 average-wage jobs. Table 2.9 also presents the results in terms of labour income, non-labour income, and sales. Note that since the starting point for measuring this impact was already in terms of the growth in GRP, which includes multiplier effects, we do not need to measure the direct, indirect, and induced effects as in the other impacts discussed in previous sections.

9 The 2% of foreign research and development funding represents funding at the provincial level in 2010. However, given data limitations, we use the 2% as a proxy for current foreign research and development funding in the region. See Statistics Canada, "Table 4-2: Provincial distribution of gross domestic expenditures on research and development — By funding sector, 2010."

STUDENT SPENDING IMPACT

Both in-region and out-of-region students, domestic and international, contribute to the student spending impact of Calgary PSIs; however, not all of these students can be counted towards the impact. Only the out-of-region students who relocated to the Calgary Census Metropolitan Area to attend Calgary PSIs are measured. Students who

TABLE 2.10: Average annual student cost of attendance and total sales generated by Calgary PSIs' out-of-region students and in-region retained students in the Calgary Census Metropolitan Area, FY 2014-15

Room and board	$10,650
Personal expenses	$2,500
Transportation	$900
Total expenses per student (A)	**$14,050**
Number of students at Calgary PSIs who relocated to region (B)	7,904
Number of students at Calgary PSIs retained in region (C)	8,946
Gross sales generated by students who relocated (A*B)	$111,057,273
Gross sales generated by retained students (A*C)	$125,692,178
Total gross student sales	**$236,749,451**

* Numbers may not add due to rounding.

Source: Data on the number of students who relocate supplied by Calgary PSIs. Data on the cost of attendance calculated by Emsi based on a report by Roslyn Kunin and Associates.

TABLE 2.11: Student spending impact, FY 2014-15

	LABOUR INCOME (THOUSANDS)	NON-LABOUR INCOME (THOUSANDS)	TOTAL INCOME (THOUSANDS)	SALES
Initial effect	**$0**	**$0**	**$0**	**$236,749**
MULTIPLIER EFFECT				
Direct effect	$25,865	$30,262	$56,128	$139,743
Indirect effect	$10,016	$10,653	$20,669	$52,946
Induced effect	$7,922	$9,429	$17,351	$41,492
Total multiplier effect	**$43,803**	**$50,345**	**$94,148**	**$234,181**
Total impact (initial + multiplier)	**$43,803**	**$50,345**	**$94,148**	**$470,930**

Source: Emsi CRIO model.

commute from outside the region or take courses online are not counted towards the student spending impact because they are not adding money from living expenses to the region. Of the in-region students, only those students who were retained, or who would have left the region to seek education elsewhere had Calgary PSIs not existed, are measured. Students who would have stayed in the region anyway are not counted towards the impact since their monies would have been added to the Calgary Census Metropolitan Area economy regardless of Calgary PSIs.

A total of 7,904 students at Calgary PSIs relocated to the Calgary Census Metropolitan Area from either outside of the region or outside Canada to attend the institutions in FY 2014-15. These students spent money at regional businesses to purchase groceries, rent accommodation, pay for transportation, and so on. The expenditures of Calgary PSIs' out-of-region students supported regional jobs and created new income in the regional economy.[10]

While there were 89,461 students attending Calgary PSIs who originated from the Calgary Census Metropolitan Area, not all of them would have remained in the region if not for the existence of Calgary PSIs. We apply a conservative assumption that 10% of these in-region students would have left the Calgary Census Metropolitan Area for other education opportunities if Calgary PSIs did not exist. Therefore, we recognize that the in-region spending of 8,946 students is attributable to Calgary PSIs.

The average living expenses of students in the Calgary Census Metropolitan Area appears in the first section of Table 2.10 (on the previous page), equal to $14,050 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 spending impact discussed in the previous section. Multiplying the $14,050 in annual costs by the number of students who relocated to the region or were retained in the region generates gross sales of $236.7 million.

Estimating the impacts generated by the $236.7 million in student spending follows a procedure similar to that of the operations impact described above. We begin by mapping the $236.7 million in sales to the industry sectors in the CRIO model, apply RPCs to reflect regional 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 2.11 presents the results. The initial income effect is $0 because the impact of out-of-region and retained students only occurs when they spend part of their earnings to make a purchase at a regional business. The income impact of out-of-region and retained student spending thus falls entirely under the multiplier effect, equal to a total of $94.1 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

10 Online students and students who commute to the Calgary Census Metropolitan Area are not considered in this calculation because their living expenses predominantly occur in the region where they reside.

spending of the household sector throughout the regional economy as a result of the direct and indirect effects. This is equivalent to 1,599 average-wage jobs.

VISITOR SPENDING IMPACT

In addition to students from outside the region, thousands of visitors came to Calgary PSIs to participate in various activities, including commencement, alumni events, sports events, and orientation. Approximately 46,674 out-of-region visitors attended events hosted by Calgary PSIs in FY 2014-15.[11]

Table 2.12, on the next page, presents the average expenditures per person-trip for accommodation, food, transportation, and other personal expenses (including shopping and entertainment). These figures were reported by Calgary PSIs. Based on these figures, the gross spending of out-of-region visitors totaled $11.4 million in FY 2014-15. However, some of this spending includes monies paid to Calgary PSIs through non-textbook items (e.g., event tickets, food, etc.). These have already been accounted for in the operations spending impact and should thus be removed to avoid double-counting. We estimate that on-campus sales generated by out-of-region visitors totaled $1.9 million. The net sales from out-of-region visitors in FY 2014-15 thus come to $9.5 million.

Calculating the increase in regional income as a result of visitor spending again requires use of the CRIO model. The analysis begins by discounting the off-campus sales generated by out-of-region visitors to account for leakage in the trade sector, and then bridging the net figures to the detailed sectors of the CRIO model. The model runs the net sales figures through the multiplier matrix to arrive at the multiplier effects. As shown in Table 2.13, the net impact of visitor spending in FY 2014-15 comes to $2.8 million in labour income and $1.7 million in non-labour income. This

TABLE 2.12: Average visitor costs and sales generated by out-of-region visitors in the Calgary Census Metropolitan Area, FY 2014-15

Accommodation	$61
Food and dining	$88
Transportation	$48
Personal expenses	$48
Total expenses per visitor	**$245**
Number of out-of-region visitors	46,674
Gross sales	**$11,435,113**
On-campus sales (excluding textbooks)	$1,922,966
Net off-campus sales	**$9,512,147**

Source: Sales calculations by Emsi estimated based on data provided by Calgary PSIs.

11 Out-of-region visitors provided by Calgary PSIs. In the event an institution was unable to provide an estimate, Emsi calculated an estimate based on 2 visitors per the institution's out-of-region students.

TABLE 2.13: Visitor spending impact, FY 2014-15

	LABOUR INCOME (THOUSANDS)	NON-LABOUR INCOME (THOUSANDS)	TOTAL INCOME (THOUSANDS)	SALES
Initial effect	**$0**	**$0**	**$0**	**$9,512**
MULTIPLIER EFFECT				
Direct effect	$1,665	$994	$2,659	$7,048
Indirect effect	$649	$390	$1,039	$2,763
Induced effect	$532	$317	$849	$2,098
Total multiplier effect	**$2,846**	**$1,702**	**$4,548**	**$11,909**
Total impact (initial + multiplier)	**$2,846**	**$1,702**	**$4,548**	**$21,421**

Source: Emsi impact model.

totals $4.5 million in total added income and is equivalent to 77 average-wage jobs.

ALUMNI IMPACT

Calgary PSIs' greatest economic impact stems from the education, skills training, and career enhancement that they provide. Since they were established, the institutions have 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 Calgary Census Metropolitan Area 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 Calgary PSIs student productivity on the Calgary Census Metropolitan Area economy.

The alumni impact differs from the institutional operations impact, research impact, student spending impact, and visitor spending impact in one fundamental way. Whereas the above listed impacts depend on an annually-renewed injection of new sales into the regional economy, the alumni impact is the result of years of past instruction and the associated workforce accumulation of Calgary PSIs skills. Should Calgary PSIs cease to exist, all impacts except the alumni impact would also immediately cease to exist; however, the impact of the institutions' 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 alumni comprises two main components. The first and largest of these is the added earnings (i.e., wages and salaries) of former students of Calgary PSIs. 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. For example, a skilled worker can operate production equipment more efficiently, 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 students of Calgary PSIs.

TABLE 2.14: Number of Calgary PSIs credits still active in workforce and added earnings created in region

Number of credits in workforce	20,577,017
Average value per credit	$189
Added earnings, gross	**$3,891,589,957**
Percent reduction for alternative education opportunities	15%
Percent reduction for adjustment for substitution	50%
Added earnings, net	**$1,647,133,174**

Source: Emsi impact model.

The first step in estimating the initial effect of alumni is to determine the added earnings that accrue to students because of their education. We begin by assembling the record of Calgary PSIs' historical student headcounts (both credit and non-credit) over the past 30 years,[12] from 1985-86 to 2014-15. From this vector of historical enrollments, we remove the number of students who are not currently active in the regional workforce, whether because they 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;[13] 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 students who were still actively employed in the region as of FY 2014-15.

12 We apply a 30-year time horizon because the data on students who attended Calgary PSIs prior to1985-86 is less reliable, and because most of the students whom Calgary PSIs served more than 30 years ago had left the regional workforce by FY 2014-15.

13 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.

The next step is to transition from the number of students who were still employed in the region to the number of skills they acquired from Calgary PSIs. The students' course load, measured in terms of full-load equivalents (FLEs) serves as a reasonable proxy for accumulated skills. Table 1.4 in Chapter 1 provides the number of FLEs generated by the Calgary PSIs student population in FY 2014-15, equal to 58,834 FLEs (excluding the FLE production of personal enrichment students). This value we convert to credits by multiplying it by a factor of 30, the assumed number of credits per FLE.[14] The converted FLEs thus yield 1.8 million credits for the year.

The 1.8 million credits only represent the total credit production for the FY 2014-15 student population, however. What we need is an estimate of the Calgary PSIs' historical credit production. To derive this, we determine the average number of credits per student during the analysis year – equal to 17.4 credits – and multiply this by the number of former students of Calgary PSIs still active in the workforce during the analysis year. The end product – 20.6 million credits – appears in the top row of Table 2.14 (on the previous page).

The next row in Table 2.14 shows the average value per credit, equal to $189. This value represents the average increase in wages that former students of Calgary PSIs received during the analysis year for every credit generated at the institutions. The value per credit varies depending on the students' age, with the highest value applied to the credit production of students who had been employed the longest by FY 2014-15, and the lowest value per credit applied to students who were just entering the workforce. More information on the theory and calculations behind the value per credit appears in Appendix 6. In determining the amount of added earnings that accrue to former students, we multiply the credit production of Calgary PSIs' former students in each year of the historical time horizon by the corresponding average value per credit for that year, then sum the products together. This calculation yields approximately $3.9 billion in gross higher wages received by former students in FY 2014-15 (as shown in Table 2.14).

14 Converting FLEs to credits in this fashion allows us to break down the students' progression into a larger number of smaller increments. Institutions may have different methods for determining credit assignments; however, a general guideline is that since 1 week of full-time study earns 1 credit, and since there are 30 weeks in a typical academic year, then one FLE earns 30 credits.

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 Calgary PSIs and subsequent influx of skilled labour into the regional 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 Calgary PSIs and the other publicly-funded institutions in the region 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 15% reduction of the $3.9 billion in added earnings, meaning that 15% of the added earnings would have been generated in the region anyway, even if Calgary PSIs did not exist. For more information on the calculation of the alternative education variable, see Appendix 7.

The other adjustment in Table 2.14 accounts for the substitution of workers. Suppose Calgary PSIs 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 Calgary Census Metropolitan Area. 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 Calgary PSIs did not exist.[15] With the 50% adjustment, the net added earnings in the economy come to $1.6 billion, as shown in Table 2.14.

The $1.6 billion in added earnings appears under the initial effect in the "Earnings" column of Table 2.15. 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 304 industry sectors of the CRIO model.

The sub-model relies on three assumptions. First, students

15 For a sensitivity analysis of the substitution variable, see Chapter 4.

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 opposed to less advanced, industries.

The notion of technical advance needs further explanation. An enduring theory describes economic development as a process of progressive stages. Parr (1999)[16] provides a recent update employing the following four stages: primary production (i.e., raw agricultural production, fishing and mining production, etc.), process manufacturing (i.e., manufacturing that uses primary products as inputs), fabricative manufacturing (i.e., manufacturing that uses manufactured goods as inputs), and producer services and capital export (i.e., legal, business and professional consulting and services, banking and financial services, capital equity providers, etc.). The technical advance of an industry generally parallels its stage, thus primary production is the least technically advanced, process manufacturing more advanced, fabricative manufacturing still more so, and so on. We weight industries based on Parr's stages, with low weights for lower stage sectors and higher weights for higher development sectors. The process pulls students in the direction of higher stage as opposed to lower stage industries.

Once students are distributed across the 304 industry sectors of the CRIO model, we multiply our estimate of the students' initial earnings effect ($1.6 billion) by the ratio of other income to earnings provided by the CRIO model for each sector. This computation yields an estimated $2.2 billion in other income attributable to the former students of Calgary PSIs. Summing initial earnings and other income together provides the total initial effect of alumni in the Calgary Census Metropolitan Area economy, equal to approximately $3.9 billion.

The next few rows of Table 2.15 show the multiplier effects of alumni. 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 Calgary PSIs' 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 students from Calgary PSIs.

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

TABLE 2.15: Alumni impact

	LABOUR INCOME (THOUSANDS)	NON-LABOUR INCOME (THOUSANDS)	TOTAL INCOME (THOUSANDS)	SALES
Initial effect	**$1,647,133**	**$2,223,848**	**$3,870,981**	**$8,423,251**
MULTIPLIER EFFECT				
Direct effect	$332,170	$451,178	$783,348	$2,049,078
Indirect effect	$113,588	$146,812	$260,400	$597,226
Induced effect	$651,574	$710,599	$1,362,173	$2,532,580
Total multiplier effect	**$1,097,332**	**$1,308,590**	**$2,405,922**	**$5,178,884**
Total impact (initial + multiplier)	**$2,744,466**	**$3,532,437**	**$6,276,903**	**$13,602,135**

Source: Emsi CRIO model.

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 $1.1 billion in earnings and $1.3 billion in other income, for an overall total of $2.4 billion in multiplier effects. The grand total impact of alumni thus comes to $6.3 billion, the sum of all initial and multiplier effects. This is equivalent to 106,624 average-wage jobs. The total figures appear in the last row of Table 2.15.

SUMMARY OF ECONOMIC IMPACTS

Table 2.16, on the next page, displays the grand total of Calgary PSIs' impact on the Calgary Census Metropolitan Area in FY 2014-15, including the institutional operations spending impact, the research spending impact, the start-up and spin-off impact, the total factor productivity impact, the student spending impact, the visitor spending impact, and the alumni impact. In total, Calgary PSIs add $8.6 billion in income to the Calgary Census Metropolitan Area economy. This is equivalent to 145,936 average-wage jobs.

These results demonstrate several important points. First, Calgary PSIs promote regional economic growth through their own operations spending, their research spending, the spending of their start-up and spin-off companies, their impact on total factor productivity, the spending of their non-local students and retained students, the spending of their visitors, and through the increase in productivity as former students from Calgary PSIs remain active in the regional workforce. Second, the alumni impact is by far the largest and most important impact of Calgary PSIs, stemming from the higher earnings and other income of students and their employers. And third, regional income in the Calgary Census Metropolitan Area would be substantially lower without the educational activities of Calgary PSIs.

TABLE 2.16: Total impacts of Calgary PSIs, FY 2014-15

	LABOUR INCOME (THOUSANDS)	NON-LABOUR INCOME (THOUSANDS)	TOTAL INCOME (THOUSANDS)	SALES
Institutional operations spending	$1,279,152	$273,168	$1,552,321	$2,811,201
Research spending	$203,697	$74,893	$278,590	$580,416
Start-up and spin-off companies	$20,845	$29,634	$50,479	$126,024
Total factor productivity	$194,588	$139,597	$334,185	$632,325
Student spending	$43,803	$50,345	$94,148	$470,930
Visitor spending	$2,846	$1,702	$4,548	$21,421
Alumni	$2,744,466	$3,532,437	$6,276,903	$13,602,135
Total impact	**$4,489,398**	**$4,101,776**	**$8,591,173**	**$18,244,452**
% of Calgary Census Metropolitan Area economy	11.4%	4.9%	7.0%	6.9%

Source: Emsi CRIO model.

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 Calgary PSIs as an investment from the perspectives of students, society, and taxpayers. The backdrop for the investment analysis for society and taxpayers is the entire province.

STUDENT PERSPECTIVE

Analyzing the benefits and costs of education from the perspective of students is the most obvious form of investment analysis this study considers. Generally, students enter postsecondary institutions because their goal is to improve their career pathway and therefore lifetime earnings potential. They realize this is their future payoff for giving up time and money to go to the institutions today. 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.

Calculating student costs

Student costs consist of two main items: direct outlays and opportunity costs. Direct outlays include tuition and fees, equal to $440.8 million from Table 1.2. 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.[17] Multiplying this figure times the number of full-load equivalents (FLEs) produced by Calgary PSIs in FY 2014-15 (see Table 1.4) generates a total cost of $70.6 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 the institutions rather than work. To calculate it, we need to know the difference between the students' full earning potential and what they actually earn while attending the institutions.

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.[18] The earnings in Table 1.7 reflect the midpoint of the average worker's career, however, not his or her earnings while attending the institutions. Because of this, we adjust the earnings to the average age of the student population (27) to better reflect their earnings at their current age.[19] This calculation yields an average full earning potential of $31,469 per student.

In determining what students earn while attending the institutions, an important factor to consider is the time that they actually spend at the institutions, since this is the only time

17 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.

18 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.

19 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 6.

that they are required to give up a portion of their earnings. We use the students' FLE production as a proxy for time, under the assumption that the more FLEs students earn, the less time they have to work, and, consequently, the greater their forgone earnings. Overall, students from Calgary PSIs earned an average of 0.58 FLEs per student, which is equal to 57.9% of a full academic year. We thus include no more than $18,228 (or 57.9%) of the students' full earning potential in the opportunity cost calculations.

Another factor to consider is the students' employment status while attending the institutions. Calgary PSIs estimate that 75% of their students are employed.[20] For the 25% who are not working, we assume that they 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 the institutions, therefore, non-working students give up everything that they can potentially earn during the academic year (i.e., the $18,228). The total value of their forgone earnings thus comes to $484.2 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 the institutions.[21] 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.[22] The amount of leisure time that students forgo is approximately 1.9 hours per day.[23] 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 $816.1 million, equal to the sum of their foregone earnings ($458.5 million) and forgone leisure time ($357.6 million).

The steps leading up to the calculation of student costs during the reporting year appear in Table 3.1. Direct outlays amount to $496.7 million, the sum of tuition and fees ($440.8 million) and books and supplies ($70.6 million), less $14.7 million in direct outlays for personal enrichment students (these students are excluded from the cost calculations). Opportunity costs for working and non-working students amount to $1.3 billion. Summing all values together yields a total of $1.8 billion in student costs.

TABLE 3.1: Calgary PSIs student costs (thousands), FY 2014-15

DIRECT OUTLAYS	
Tuition and fees	$440,810
Books and supplies	$70,601
Less direct outlays personal enrichment students	-$14,743
Total direct outlays	**$496,668**
OPPORTUNITY COSTS	
Earnings forgone by non-working students	$484,156
Earnings forgone by working students	$458,472
Value of leisure time forgone by working students	$357,580
Total opportunity costs	**$1,300,207**
Total student costs	**$1,796,876**

Source: Based on data supplied by Calgary PSIs and outputs of the Emsi impact model.

20 Based on the number of students who reported their employment status to Calgary PSIs.

21 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.

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

23 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 Labour 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.

Linking education to earnings

Having estimated the costs of education to students, we weigh these 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.[24]

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 Calgary PSIs' FY 2014-15 students first by determining their average annual increase in earnings, equal to $378.9 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 the institutions. For a full description of the methodology used to derive the $378.9 million, see Appendix 6.

The second step is to project the $378.9 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 slope of the earnings function developed by Jacob Mincer to predict the change in earnings at each age in an individual's working career.[25] Appendix 6 provides more information on the Mincer function and how it is used to predict future earnings growth. With the $378.9 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, on the next page.

The final step in calculating the students' future benefits stream is to net out the potential benefits generated by students who are either not yet active in the workforce or who leave the workforce over time. This adjustment appears in Column 3 of Table 3.2 and represents the percentage of the total FY 2014-15 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 institutions 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.

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%[26] (see the "Discount Rate" box). The present value of the benefits is then compared to student costs to derive the investment

24 As discussed in Appendix 6, 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.

25 See Mincer, 1958.

26 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%.

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	$240.2	28%	$68.3	$1,796.9	-$1,728.6
1	$249.5	39%	$96.5	$0.0	$96.5
2	$258.7	46%	$154.0	$0.0	$118.8
3	$267.7	58%	$13.6	$0.0	$154.0
4	$276.6	74%	$205.2	$0.0	$205.2
5	$285.4	94%	$267.4	$0.0	$267.4
6	$293.9	94%	$275.9	$0.0	$275.9
7	$302.2	94%	$284.2	$0.0	$284.2
8	$310.2	94%	$292.1	$0.0	$292.1
9	$317.9	94%	$299.6	$0.0	$299.6
10	$325.3	94%	$306.8	$0.0	$306.8
11	$332.3	94%	$313.5	$0.0	$313.5
12	$339.0	94%	$319.8	$0.0	$319.8
13	$345.2	94%	$325.7	$0.0	$325.7
14	$351.0	94%	$331.0	$0.0	$331.0
15	$356.4	94%	$335.8	$0.0	$335.8
16	$361.3	94%	$340.1	$0.0	$340.1
17	$365.7	94%	$343.8	$0.0	$343.8
18	$369.6	94%	$347.0	$0.0	$347.0
19	$372.9	94%	$349.5	$0.0	$349.5
20	$375.7	94%	$351.5	$0.0	$351.5
21	$378.0	93%	$352.8	$0.0	$352.8
22	$379.7	93%	$353.5	$0.0	$353.5
23	$380.8	93%	$353.6	$0.0	$353.6
24	$381.4	91%	$348.0	$0.0	$348.0
25	$381.4	85%	$325.0	$0.0	$325.0
26	$380.8	80%	$304.8	$0.0	$304.8
27	$379.6	76%	$286.9	$0.0	$286.9
28	$377.9	72%	$270.5	$0.0	$270.5
29	$375.6	60%	$227.1	$0.0	$227.1
30	$372.7	51%	$190.2	$0.0	$190.2
31	$369.4	40%	$147.5	$0.0	$147.5
32	$365.4	31%	$111.8	$0.0	$111.8
33	$361.0	23%	$82.4	$0.0	$82.4
34	$356.1	16%	$58.7	$0.0	$58.7
35	$350.7	11%	$40.2	$0.0	$40.2
36	$318.9	8%	$26.1	$0.0	$26.1
37	$224.7	7%	$16.0	$0.0	$16.0
38	$221.0	4%	$9.3	$0.0	$9.3
39	$213.8	2%	$5.0	$0.0	$5.0
40	$209.6	1%	$2.4	$0.0	$2.4
41	$60.1	1%	$0.8	$0.0	$0.8
42	$5.5	1%	$0.0	$0.0	$0.0
Present value of cash flows			**$5,515.0**	**$1,796.9**	**$3,718.1**
Benefit-cost ratio					3.1
Return on investment (ROI)					2.1
Internal rate of return					13.5%
Payback period (no. of years)					9.1

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

Source: Emsi college impact model.

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 3.27% discount rate from the student perspective and a 1.76% 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.

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.

In Table 3.2, the higher earnings of Calgary PSIs' 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 discounted to the present. This yields a cumulative sum of approximately $5.5 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 FY 2014-15 student body is rewarded for their investment in Calgary PSIs with a capital asset valued at $5.5 billion.

The students' cost of attending Calgary PSIs is shown in Column 5 of Table 3.2, equal to a present value of $1.8 billion. Note that costs only occur in the single analysis year and are thus already in current year dollars. Comparing the cost with the present value of benefits yields a student benefit-cost ratio of 3.1 (equal to $5.5 billion in benefits divided by $1.8 billion 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 $1 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 students from Calgary PSIs, an ROI of 2.1 means that the students receive an additional $2.10 in present value terms for every $1 they invest in the institutions.

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.[27] Table 3.2 shows Calgary PSIs' students earning average returns of 13.5% 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 13.5% 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

27 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.

Index), the corresponding nominal rate of return is 15.3%, 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.[28] Beyond that point, returns are what economists would call "pure costless rent." As indicated in Table 3.2, students at Calgary PSIs see, on average, a payback period of 9.1 years on their forgone earnings and out-of-pocket costs.

SOCIAL PERSPECTIVE

Society as a whole in Alberta benefits from the education that Calgary PSIs provide through the income that students create in the province and through the savings that they generate through their improved lifestyles. Additionally, society benefits from the improved quality of life in Alberta due to advancements in health care from research at Calgary PSIs. To receive these benefits, however, members of society must pay money and forgo services that they would have otherwise enjoyed if Calgary PSIs did not exist. Society's investment in Calgary PSIs stretches across a number of investor groups, from students to employers to taxpayers. We weigh the benefits generated by Calgary PSIs to these investor groups against the total social costs of generating those benefits. The total social costs include all Calgary PSIs expenditures, all student expenditures, and all student opportunity costs. The social costs come to a total of $3.4 billion.

On the benefits side, any benefits that accrue to society as a whole – including students, employers, taxpayers, and anyone else who stands to benefit from the activities of Calgary PSIs – 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.

It is important to note that by comparing benefits to society against costs to taxpayers, 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 taxpayers and that, because of this, the results calculated on the basis of those benefits should be viewed strictly as a comparison between public benefits and taxpayer costs.

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, research adds to community health and productivity, 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.

28 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.

Income growth in the province

In the process of absorbing the newly-acquired skills of Calgary PSIs' students, not only does the productivity of Alberta'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 the institutions, 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 Calgary PSIs 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.[29] 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 Alberta's Gross Provincial Product to total earnings in the province. We also include the spending impacts discussed in Chapter 2 that were created in FY 2014-15 by the operations of the institutions and their research activities, as well as spending from students and visitors.

The sum of the students' higher incomes, multiplier effect, increase in non-labour income, and spending impacts comprises the gross added income that accrues to communities and citizens throughout 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 Calgary PSIs 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 alumni impact in Chapter 2 and is designed to account for the counterfactual scenario where Calgary PSIs do not exist. The assumption in this case is that any benefits generated by students who could have received an education even without Calgary PSIs cannot be counted as new benefits to society.[30] For this analysis, we estimate an alternative education variable of 15%, meaning that 15% of the student population at Calgary PSIs would have generated benefits anyway even without the institutions. For more information on the calculation of the alternative education variable, see Appendix 7.

Another adjustment – the "shutdown point" – nets out benefits that are not directly linked to the provincial government costs of supporting the institutions. 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 Calgary PSIs 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 Calgary PSIs, the shutdown point adjustment is 1%, meaning that the Calgary PSIs could not operate without taxpayer support. As such, no reduction applies. For more information on the theory and methodology behind the estimation of the shutdown point, see Appendix 9.

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 $20.3 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

29 For a full description of the CRIO model, see Appendix 5.

30 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 Calgary PSIs in standard investment analysis terms by accounting for benefits that would have occurred anyway, even if the institutions did not exist.

discount rate in this case is 1.76%, the real treasury interest rate recommended by the Bank of Canada for long-term investments.[31]

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 Calgary PSIs. Social benefits appear in Table 3.3 and break down into three main categories: 1) health savings, 2) crime savings, and 3) income assistance savings. Health savings include avoided medical costs, 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.

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 Calgary PSIs, 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 6 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.[32] 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	**$20,294,187**
SOCIAL SAVINGS	
Health	
Smoking	$62,647
Alcoholism	$16,531
Obesity	$10,926
Mental illness	$9,633
Total health savings	**$99,736**
Crime	
Criminal Justice System savings	$805
Crime victim savings	$1,553
Added productivity	$476
Total crime savings	**$2,834**
Income assistance	
Employment insurance savings	$4,581
Employment-related social assistance savings	$3,142
Total income assistance savings	**$7,723**
Total social savings	**$110,294**
Total, added income + social savings	**$20,404,481**

Source: Emsi college impact model.

Table 3.3 displays the results of the analysis. The first row shows the added income created in the province, equal to $20.3 billion. Social savings appear next, beginning with a breakdown of savings related to health. These savings amount to a present value of $99.7 million, including savings due to a reduced demand for medical treatment and social services, improved worker productivity and reduced absenteeism, and a reduced number of vehicle crashes and fires induced by alcohol or smoking-related incidents. Crime savings sum to $2.8 million, including savings associated with a reduced number of crime victims, added

31 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/.

32 For a full list of the data sources used to calculate the social externalities, see Appendix 5. See also Appendix 10 for a more in-depth description of the methodology.

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	$2,297.5	$3,376.0	-$1,078.5
1	$280.3	$0.0	$280.3
2	$342.8	$0.0	$342.8
3	$440.2	$0.0	$440.2
4	$580.2	$0.0	$580.2
5	$748.5	$0.0	$748.5
6	$766.9	$0.0	$766.9
7	$784.4	$0.0	$784.4
8	$801.0	$0.0	$801.0
9	$816.5	$0.0	$816.5
10	$831.0	$0.0	$831.0
11	$844.4	$0.0	$844.4
12	$856.7	$0.0	$856.7
13	$867.8	$0.0	$867.8
14	$877.7	$0.0	$877.7
15	$886.3	$0.0	$886.3
16	$893.7	$0.0	$893.7
17	$899.8	$0.0	$899.8
18	$904.6	$0.0	$904.6
19	$908.1	$0.0	$908.1
20	$910.3	$0.0	$910.3
21	$911.1	$0.0	$911.1
22	$910.5	$0.0	$910.5
23	$908.6	$0.0	$908.6
24	$891.5	$0.0	$891.5
25	$825.6	$0.0	$825.6
26	$767.9	$0.0	$767.9
27	$717.1	$0.0	$717.1
28	$671.4	$0.0	$671.4
29	$560.4	$0.0	$560.4
30	$466.3	$0.0	$466.3
31	$360.4	$0.0	$360.4
32	$272.2	$0.0	$272.2
33	$199.8	$0.0	$199.8
34	$141.8	$0.0	$141.8
35	$96.7	$0.0	$96.7
36	$62.7	$0.0	$62.7
37	$38.1	$0.0	$38.1
38	$22.1	$0.0	$22.1
39	$11.8	$0.0	$11.8
40	$5.7	$0.0	$5.7
41	$1.8	$0.0	$1.8
42	$0.1	$0.0	$0.1
Net present value	**$20,404.5**	**$3,376.0**	**$17,028.5**
Benefit-cost ratio			6.0

Source: Emsi college impact model.

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 $7.7 million, stemming from a reduced number of persons in need of employment insurance and employment-related social assistance. All told, social savings amounted to $110.3 million in benefits to society as a whole in Alberta.

The sum of the social savings and the added income in the province is $20.4 billion, as shown in the bottom row of Table 3.3. These savings accrue for years out into the future, for as long as Calgary PSIs' FY 2014-15 students remain in the workforce.

Benefit-cost ratio to society

The $20.4 billion in present value benefits re-appears at the bottom of Column 2 in Table 3.4, on the previous page. Total social support of Calgary PSIs is listed in the next column, equal to $3.4 billion.

Comparing the present value of the benefits and the social costs, we have a benefit-cost ratio of 6.0. This means that for every $1 invested in Calgary PSIs educations, whether it is the money spent on day-to-day operations of the institutions or money spent by students on tuition and fees, an average of $6.00 in benefits will accrue to society in Alberta.

TAXPAYER PERSPECTIVE

From the taxpayer 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, provincial businesses, or the federal government are excluded.

Benefits to taxpayers

Table 3.5 displays the present value of the benefits to taxpayers. 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 Alberta. 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 $3.5 billion.

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

Added tax revenue	**$3,484,672**
GOVERNMENT SAVINGS	
Health-related savings	$33,641
Crime-related savings	$900
Income assistance savings	$7,723
Total government savings	**$42,264**
Total taxpayer benefits	**$3,526,936**

Source: Emsi impact model.

Return on investment

Taxpayer costs are reported in Table 3.6, on the next page, and come to $993.7 million, equal to the annual contribution of provincial government to Calgary PSIs. In return for their public support, therefore, taxpayers are rewarded with an investment benefit-cost ratio of 3.5 (= $3.5 billion ÷ $993.7 million). The return on investment is $2.50, indicating a profitable investment.

At 17.6%, the rate of return to provincial taxpayers is also favourable. As above, we assume a 1.76% 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 1.76% would mean that the institutions just pay their own way. In principle, governments could borrow monies used to support Calgary PSIs and repay the loans out of the resulting added taxes and reduced government expenditures. A rate of return of 17.6%, on the other hand, means that Calgary PSIs not only pay their own way, but they also generate a

TABLE 3.6: Projected benefits and costs, taxpayer perspective

1	2	3	4
YEAR	BENEFITS TO THE PROVINCIAL GOV'T (MILLIONS)	PROVINCIAL GOV'T COSTS (MILLIONS)	NET CASH FLOW (MILLIONS)
0	$395.0	$993.7	-$598.7
1	$48.7	$0.0	$48.7
2	$59.5	$0.0	$59.5
3	$76.3	$0.0	$76.3
4	$100.6	$0.0	$100.6
5	$129.7	$0.0	$129.7
6	$132.8	$0.0	$132.8
7	$135.8	$0.0	$135.8
8	$138.7	$0.0	$138.7
9	$141.3	$0.0	$141.3
10	$143.8	$0.0	$143.8
11	$146.1	$0.0	$146.1
12	$148.2	$0.0	$148.2
13	$150.1	$0.0	$150.1
14	$151.8	$0.0	$151.8
15	$153.3	$0.0	$153.3
16	$154.5	$0.0	$154.5
17	$155.6	$0.0	$155.6
18	$156.4	$0.0	$156.4
19	$157.0	$0.0	$157.0
20	$157.4	$0.0	$157.4
21	$157.5	$0.0	$157.5
22	$157.4	$0.0	$157.4
23	$157.1	$0.0	$157.1
24	$154.1	$0.0	$154.1
25	$142.7	$0.0	$142.7
26	$132.7	$0.0	$132.7
27	$123.9	$0.0	$123.9
28	$116.0	$0.0	$116.0
29	$96.8	$0.0	$96.8
30	$80.5	$0.0	$80.5
31	$62.2	$0.0	$62.2
32	$47.0	$0.0	$47.0
33	$34.5	$0.0	$34.5
34	$24.5	$0.0	$24.5
35	$16.7	$0.0	$16.7
36	$10.8	$0.0	$10.8
37	$6.6	$0.0	$6.6
38	$3.8	$0.0	$3.8
39	$2.0	$0.0	$2.0
40	$1.0	$0.0	$1.0
41	$0.2	$0.0	$0.2
42	<$0.0	$0.0	<$0.0
Net present value	**$3,526.9**	**$993.7**	**$2,533.3**
Benefit-cost ratio			3.5
Return on investment (ROI)			2.5
Internal rate of return			17.6%
Payback period (no. of years)			7.4

Source: Emsi college impact model.

surplus that provincial government can use to fund other programs. It is unlikely that other government programs could make such a claim.

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 institutions. 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 Calgary PSIs. Recognizing the other point of view, Table 3.7 shows the results for both the social and taxpayer 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 1.1%,) confirming that taxpayers receive value from investing in Calgary PSIs.

TABLE 3.7: Social and taxpayer perspectives with and without social savings

	INCLUDING SOCIAL SAVINGS (THOUSANDS)	EXCLUDING SOCIAL SAVINGS (THOUSANDS)
SOCIAL PERSPECTIVE		
Net present value	**$17,028,476**	**$14,843,837**
Benefit-cost ratio	6.0	5.4
TAXPAYER PERSPECTIVE		
Net present value	**$2,533,252**	**$2,133,199**
Benefit-cost ratio	3.5	3.1
Return on investment	2.5	2.1
Internal rate of return	17.6%	11.5%
Payback period (no. of years)	7.4	10.1

Source: Emsi impact model.

CONCLUSION

This chapter has shown that Calgary PSIs are attractive investments to their major stakeholders – students, society, and taxpayers. 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 taxpayer funds creates a wide range of positive 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 Calgary PSIs and their 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) the alternative education variable, 2) the substitution effect variable, 3) the student employment variables, and 4) the discount rate.

ALTERNATIVE EDUCATION VARIABLE

The alternative education variable (15%) accounts for the counterfactual scenario where students would have to seek a similar education elsewhere absent the publicly-funded training providers in the region. Given the difficulty in accurately specifying the alternative education variable, we test the sensitivity of the taxpayer investment analysis results to its magnitude. Variations in the alternative education assumption are calculated around base case results listed in the middle column of Table 4.1. Next, the model brackets the base case assumption on either side with a plus or minus 10%, 25%, and 50% variation in assumptions. Analyses are then redone introducing one change at a time, holding all other variables constant. For example, an increase of 10% in the alternative education assumption (from 15% to 17%) reduces the taxpayer perspective rate of return from 17.6% to 17.0%. Likewise, a decrease of 10% (from 15% to 14%) in the assumption increases the rate of return from 17.6% to 17.9%.

Based on this sensitivity analysis, the conclusion can be drawn that Calgary PSIs' investment analysis results from the taxpayer 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 taxpayer perspective is not very sensitive.

SUBSTITUTION EFFECT VARIABLE

The substitution effect variable only affects the alumni calculation in Table 2.14. 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

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

% VARIATION IN FUNDING	-50%	-25%	-10%	BASE CASE	10%	25%	50%
Alternative education variable	8%	12%	14%	15%	17%	19%	23%
Net present value (millions)	$2,842.5	$2,680.5	$2,583.3	$2,533.3	$2,453.7	$2,356.5	$2,194.6
Benefit-cost ratio	3.9	3.7	3.6	3.5	3.5	3.4	3.2
Return on investment	2.9	2.7	2.6	2.5	2.5	2.4	2.2
Rate of return	19.7%	18.6%	17.9%	17.6%	17.0%	16.4%	15.3%

student productivity. The other 50% we assume would have been created in the region anyway – even without Calgary PSIs– since the businesses that hired Calgary PSIs' students could have substituted some of these workers with equally-qualified people from outside the region had there been no students from Calgary PSIs to hire.

Table 4.2 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. Alumni impacts attributable to Calgary PSIs, for example, range from a low of $4.4 billion at a -30% variation to a high of $8.2 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 student productivity increases as well. Nonetheless, the impact of alumni still remains a sizeable factor in the Calgary Census Metropolitan Area economy, even under the most conservative assumptions.

STUDENT EMPLOYMENT VARIABLES

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

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

The second student employment variable is more difficult to estimate. In this study we estimate that students that are working while attending the institutions earn only 57.9%, on average, of the earnings that they would have statistically received if not attending Calgary PSIs. This suggests that many students hold jobs that accommodate their attendance at Calgary PSIs, 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 estimate is tested in the sensitivity analysis

TABLE 4.2: 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%
Alumni impact (millions)	$4,393.8	$5,021.5	$5,649.2	$6,276.9	$6,904.6	$7,532.3	$8,160.0

TABLE 4.3: 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 = 75%, B = 69%	$3,718.1	3.1	2.1	13.5%
Scenario 1: A = 100%, B = 69%	$3,935.6	3.5	2.5	15.1%
Scenario 2: A = $70.6 million, B = 100%	$4,176.6	4.1	3.1	17.4%
Scenario 3: A = 100%, B = 100%	$4,543.9	5.7	4.7	22.7%
Scenario 4: A = 0%, B = 0%	$3,052.5	2.2	1.2	10.0%

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

by changing it to 100% and then to 0%.

The changes generate results summarized in Table 4.3 (on the previous page), with "A" defined as the percent of students employed and "B" defined as the percent that students earn relative to their full earning potential. Base case results appear in the shaded row – here the assumptions remain unchanged, with A equal to 75% and B equal to 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%.

- **Scenario 1:** Increasing the percent of students employed (A) from 75% to 100%, the net present value, benefit-cost ratio, return on investment, and internal rate of return improve to $3.9 billion, 3.5, 2.5, and 15.1%, respectively, relative to base case results. Improved results are attributable to a lower opportunity cost of time – all students are employed in this case.
- **Scenario 2:** Increasing earnings relative to statistical averages (B) from 69% to 100%, the net present value, benefit-cost ratio, return on investment, and internal rate of return improve to $4.2 billion, 4.1, 3.1, and 17.4%, respectively, relative to base case results – a strong improvement, again attributable to a lower opportunity cost of time.
- **Scenario 3:** Increasing both assumptions A and B to 100% simultaneously, the net present value, benefit-cost ratio, return on investment, and internal rate of return improve yet further to $4.5 billion, 5.7, 4.7, and 22.7%, 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.
- **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 $3.1 billion, 2.2, 1.2, and 10.0%, respectively, relative to base case results. These results are reflective of an increased opportunity cost – none of the students are employed in this case.[33]

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

DISCOUNT RATE

The discount rate is a rate of interest that converts future monies to their present value. In investment analysis, the discount rate accounts for two fundamental principles: 1) the time value of money, and 2) the level of risk that an investor is willing to accept. Time value of money refers to the value of money after interest or inflation has accrued over a given length of time. An investor must be willing to forgo the use of 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 3.27% discount rate for students and a 1.76% discount rate for society and taxpayers.[34] Similar to the sensitivity analysis of the alternative education variable, we vary the base case discount rates for students, society, and taxpayers 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 taxpayers in Table 4.4, on the next page.

34 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 4.4: Sensitivity analysis of discount rate

% VARIATION IN ASSUMPTION	-50%	-25%	-10%	BASE CASE	10%	25%	50%
STUDENT PERSPECTIVE							
Discount rate	1.6%	2.5%	2.9%	3.27%	3.6%	4.1%	4.9%
Net present value (millions)	$5,260.5	$4,424.7	$3,986.8	$3,718.1	$3,466.4	$3,117.9	$2,605.6
Benefit-cost ratio	3.9	3.5	3.2	3.1	2.9	2.7	2.5
Return on investment	2.9	2.5	2.2	2.1	1.9	1.7	1.5
SOCIAL PERSPECTIVE							
Discount rate	0.9%	1.3%	1.6%	1.76%	1.9%	2.2%	2.6%
Net present value (millions)	$19,735.5	$18,319.1	$17,530.5	$17,028.5	$16,544.5	$15,850.8	$14,774.5
Benefit-cost ratio	6.8	6.4	6.2	6.0	5.9	5.7	5.4
Return on investment	5.8	5.4	5.2	5.0	4.9	4.7	4.4
TAXPAYER PERSPECTIVE							
Discount rate	0.9%	1.3%	1.6%	1.76%	1.9%	2.2%	2.6%
Net present value (millions)	$3,001.2	$2,756.4	$2,620.0	$2,533.3	$2,449.6	$2,329.7	$2,143.6
Benefit-cost ratio	4.0	3.8	3.6	3.5	3.5	3.3	3.2
Return on investment	3.0	2.8	2.6	2.5	2.5	2.3	2.2

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 3.27% to 4.9%) reduces the students' benefit-cost ratio from 3.1 to 2.5. Conversely, reducing the discount rate for students by 50% (from 3.27% to 1.6%) increases the benefit-cost ratio from 3.1 to 3.9. The sensitivity analysis results for society and taxpayers show the same inverse relationship between the discount rate and the benefit-cost ratio, with the variance in results being the greatest under the social perspective (from a 6.8 benefit-cost ratio at a -50% variation from the base case to a 5.4 benefit-cost ratio at a 50% variation from the base case).

CHAPTER 5:

Conclusion

While Calgary PSIs' value to their region is larger than simply their economic impact, understanding that dollars and cents value is an important asset to understanding the institutions' value as a whole. In order to fully assess Calgary PSIs' value to the Calgary Census Metropolitan Area economy, this report has evaluated it from the perspectives of economic impact and investment analyses.

From an economic impact perspective, we calculated that Calgary PSIs generate a total economic impact of $8.6 billion on the regional economy. This represents the sum of several different impacts, including the institutions' operations spending impact ($1.6 billion); research impact ($663.3 million), which consists of the impact of research spending, the impact of start-up and spin-off companies, and the impact of total factor productivity; student spending impact ($94.1 million); visitor spending impact ($4.5 million); and alumni impact ($6.3 billion). This impact means that Calgary PSIs are responsible for 145,936 jobs in the Calgary Census Metropolitan Area.

Since Calgary PSIs' activity represents an investment by various parties, including students, society as a whole, and taxpayers, we also considered the institutions as an investment to see the value they provide to these investors. For every $1 invested by students, society, and taxpayers, Calgary PSIs offer a benefit of $3.10, $6.00, and, $3.50, respectively.

Modeling the economic value of the institutions is subject to many factors, the variability of which we considered in our Sensitivity Analysis. With this variability accounted for, we present the findings of this study as a robust picture of the economic value of Calgary PSIs.

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Appendix 1: Calgary's Postsecondary Institutions

Alberta College of Art and Design

Ambrose University

Bow Valley College

Mount Royal University

South Alberta Institute of Technology

St. Mary's University

University of Calgary[35]

35 This analysis does not include the University of Calgary's Qatar campus.

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 region. An estimate of 10%, for example, means that 10% of students do not depend directly on the existence of the institutions in order to obtain their education.

Alternative use of funds A measure of how monies that are currently used to fund the institutions might have otherwise been used if the institutions 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-load equivalent, or FLE.

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-load equivalent The full-load equivalent (FLE) 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 institutions and their students and visitors.

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 institutions and their students and visitors (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 chose 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: Frequently Asked Questions (FAQs)

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

What is economic impact analysis?

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

What is investment analysis?

Investment analysis is a standard method for determining whether or not an existing or proposed investment is economically viable. This methodology is appropriate in situations where a stakeholder puts up a certain amount of money with the expectation of receiving benefits in return, where the benefits that the stakeholder receives are distributed over time, and where a discount rate must be applied in order to account for the time value of money.

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

Yes. Regional economic data are drawn from Emsi's proprietary CRIO model, Statistics Canada, and other sources to reflect the specific earnings levels, jobs numbers, unemployment rates, population demographics, and other key characteristics of the region served by the institutions. Therefore, model results for the institutions are specific to the given region.

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

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

How does the institutions' rates of return compare to that of other institutions?

In general, Emsi discourages comparisons between institutions since many factors, such as regional economic conditions, institutional differences, and student demographics are outside of the institutions' control. It is best to compare the rate of return to the discount rates of 3.27% (for students) and 1.76% (for society and taxpayers), which can also be seen as the opportunity cost of the investment (since these stakeholder groups could be spending their time and money in other investment schemes besides education). If the rate of return is higher than the discount rate, the stakeholder groups can expect to receive a positive return on their educational investment.

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

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

Which would you rather have: a dollar right now or a dollar thirty years from now? That most people will choose a dollar now is the crux of net present value. The preference for a dollar today means today's dollar is therefore worth more than it would be in the future (in most people's opinion). Because the dollar today is worth more than a dollar in thirty years, you can't add them today as if they have equal value. You need to adjust the values. Not doing so would result in an "apples and oranges" comparison. Adjusting the values for "this time value of money" is called discounting and the result of adding them all up after discounting each value is called net present value.

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

If taxpayers invest $1 in the institutions today, they will expect a positive return for that $1 now and in the future. So that $1 invested today needs to turn into at least a $1 return for the future. But that $1 will be worth less in the future (due to inflation and so forth). The unknown of what this future $1 will actually be worth compared to the known of what it is worth today means investors need to be assured that they will receive a given return.

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

The same can be said for the institutions' stakeholders. If they spend $1 on the institutions now, they can expect a future return of 11.8%. This can provide them with the assurance that not only will the dollars they invest in the institutions now provide increased dollars in the future, but they will yield more than if they were to spend money on other projects that may not yield as high of a return.

Total Economic Impact: How do I communicate this in laymen's terms?

Big numbers are great, but putting it into perspective can be a challenge. Tables 1.5 in Chapter 1 can help. Find an industry with roughly the same "percentage of the total" as the institutions. This percentage represents its portion of the total Gross Regional Product (GRP) in the region. This allows the institutions to say that their combined brick and mortar campuses do just as much for the region as the entire utility industry, for example. This powerful statement can put the large total impact number into perspective.

Appendix 4: Example of Sales versus Income

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

Income = Sales – Intermediary Costs

For this reason, income is a more meaningful measure of new economic activity than reporting sales. This is evidenced by the use of gross domestic product – a measure of income – by economists when considering the economic growth or size of a country.

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

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

Income = $5.00 – $3.00 = $2.00

In our analysis, income can be found by summing the labour income and non-labour income. To provide context behind these figures, we also report the number of jobs associated with the income. The impacts are also reported in sales terms for reference.

Appendix 5: Emsi's Canada Regional Input-Output Model

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:

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

CREATION OF THE IO COEFFICIENTS MATRIX

Table A5.1 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.

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.

TABLE A5.1: 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

TABLE A5.2: Sample "A" matrix

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

Column elements of the input-output table (Table A5.1 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 A5.2 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.

REGIONALIZING THE NATIONAL A MATRIX

To create a regional input-output model, we "regionalize" a 304 sector version of the Canada national model derived from publicly available Canadian national L level models. Our regionalization method is based on the work of econo-

mist A.T. Flegg[36] 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.[37] 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:

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

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

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:

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

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,[38] 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 A5.3 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

TABLE A5.3: Sample FLQ matrix

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

36 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.

37 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).

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

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."

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:

$$A^R = A^N \circ F^R$$

Where:

$\circ$ = 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

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 AR 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 6: 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.

VALUE PER CREDIT

Typically, the educational achievements of students are marked by the credentials they earn. However, not all students who attended Calgary PSIs in the 2014-15 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 by correlation should be discounted by 10%.[39] As such, we reduce the marginal differences between education levels by 10%.

Next we map the credit production of Calgary PSIs' FY 2014-15 student population to the education ladder. Table 1.4 provides information on the credit production of Calgary PSIs' students broken out by educational achievement. In total, students completed 1.8 million 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, bachelor's degree graduates are allocated to the stage between the high school diploma and the bachelor's degree, 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.

39 David Card, "The causal e ect of education on earnings," *Handbook of Labour 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%)."

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:

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

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

Table A6.1 displays the result for students' aggregate annual increase in earnings (ΔE), a total of $378.9 million. By dividing this value by the students' total production of 1.8 million credits during the analysis year, we derive an overall average value of $215 per credit allows us to see the benefits to all students who attended Calgary PSIs, 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-load equivalent (FLE) 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 $16,500. We spread this $16,500 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.[40] 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

TABLE A6.1: Aggregate annual increase in earnings of students from Calgary PSIs and average value per credit

Aggregate annual increase in earnings	$378,897,512
Total credits in FY 2014-15*	1,765,026
Average value per credit	**$215**

* Excludes the credit production of leisure students.

Source: EMSI impact model.

MINCER FUNCTION

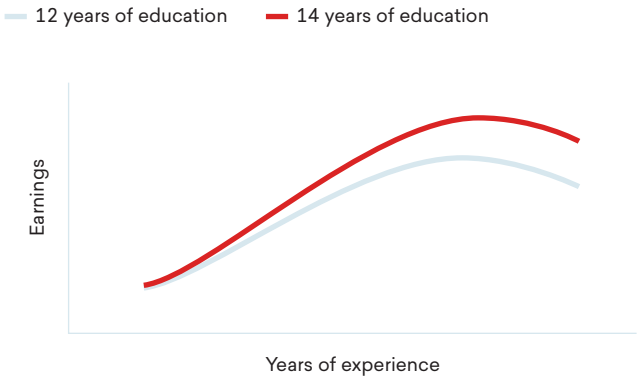
The $215 value per credit in Table A6.1 only tells part of the story, however. Human capital theory holds that earnings levels do not remain constant; rather, they start relatively low and gradually increase as the worker gains more experience. Research also shows that the earnings increment between educated and non-educated workers grows through time. These basic patterns in earnings over time were originally identified by Jacob Mincer, who viewed the lifecycle earnings distribution as a function with the key elements being earnings, years of education, and work experience, with age serving as a proxy for experience.[41] 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.

40 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.

41 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).

Figure A6.1 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 A6.1: Lifecycle change in earnings, 12 years versus 14 years of education



In calculating the alumni impact in Chapter 2, we use the slope of the curve in Mincer's earnings function to condition the $215 value per credit to the students' age and work experience.[42] To the students just starting their career during the analysis year, we apply a lower 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 $215 value per credit applies only to the credit production of

42 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 Labour Economics*, Vol. 1 (Amsterdam: Elsevier Science Publishers, 1986): 525–602. These are adjusted to current year dollars in the usual fashion by applying the GRP 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.

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 Calgary PSIs' FY 2014-15 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 A6.1.

CONCLUSION

This appendix demonstrates the significance of the value per credit and the Mincer function in determining the initial effect of alumni 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 7: Alternative Education Variable

In a scenario where Calgary PSIs do not exist, some of their students would still be able to avail themselves of an alternative comparable education. These students create benefits in the region even in the absence of the institutions. The alternative education variable accounts for these students and is used to discount the benefits presented in the analysis.

Recall this analysis considers only relevant economic information regarding Calgary PSIs. Considering the existence of various other academic institutions surrounding Calgary PSIs, we have to assume that a portion of the students could find alternative educations and either remain in or return to the Calgary Census Metropolitan Area. For example, some students may participate in online programs while remaining in the region. Others may attend an out-of-region institution and return to the Calgary Census Metropolitan Area upon completing their studies. For these students – who would have found an alternative education and produced benefits in the Calgary Census Metropolitan Area regardless of the presence of Calgary PSIs – we discount the benefits attributed to Calgary PSIs. An important distinction must be made here: the benefits from students who would find alternative educations outside the region and not return to the Calgary Census Metropolitan Area are not discounted. Because these benefits would not occur in the region without the presence of Calgary PSIs, they must be included.

In the absence of Calgary PSIs, we assume 15% of students attending Calgary PSIs would find alternative education opportunities and remain in or return to the Calgary Census Metropolitan Area. We account for this by discounting the alumni impact, the benefits to taxpayers, and the benefits to society in Alberta in Chapters 2 and 3 by 15%. In other words, we assume 15% of the benefits created by students attending Calgary PSIs would have occurred anyways in the counterfactual scenario where Calgary PSIs does not exist. A sensitivity analysis of this adjustment is presented in Chapter 4.

Appendix 8: Overview of Investment Analysis Measures

This appendix provides context to the investment analysis results using the simple hypothetical example summarized in Table A8.1 below. The table shows the projected benefits and costs for a single student over time and associated investment analysis results.[43]

Assumptions are as follows:

- Benefits and costs are projected out ten years into the future (Column 1).
- The student attends the institution for one year, and the cost of tuition is $1,500 (Column 2).
- Earnings forgone while attending college for one year (opportunity cost) come to $20,000 (Column 3).
- Together, tuition and earnings forgone cost sum to $21,500. This represents the out-of-pocket investment made by the student (Column 4).
- In return, the student earns $5,000 more per year than he would have otherwise earned without the education (Column 5).
- The net cash flow (NCF) in Column 6 shows higher earnings (Column 5) less the total cost (Column 4).
- The assumed "going rate" of interest is 4%, the rate of return from alternative investment schemes for the use of the $21,500.

Results are expressed in standard investment analysis terms, which are as follows: the net present value, the internal rate of return, the benefit-cost ratio, 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 A8.1.

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

TABLE A8.1: Example of the benefits and costs of education for a single student

1	2	3	4	5	6
YEAR	TUITION	OPPORTUNITY COST	TOTAL COST	HIGHER EARNINGS	NET CASH FLOW
1	$1,500	$20,000	$21,500	$0	-$21,500
2	$0	$0	$0	$5,000	$5,000
3	$0	$0	$0	$5,000	$5,000
4	$0	$0	$0	$5,000	$5,000
5	$0	$0	$0	$5,000	$5,000
6	$0	$0	$0	$5,000	$5,000
7	$0	$0	$0	$5,000	$5,000
8	$0	$0	$0	$5,000	$5,000
9	$0	$0	$0	$5,000	$5,000
10	$0	$0	$0	$5,000	$5,000
Net present value			**$21,500**	**$35,753**	**$14,253**
Internal rate of return					18%
Benefit-cost ratio					1.7
Return on investment					0.7
Payback period					4.2 years

NET PRESENT VALUE

The student in Table A8.1 can choose either to attend college or to forgo postsecondary 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 postsecondary 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 A8.1, 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.[44]

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 A8.1, the cumulative present value of $5,000 worth of higher earnings between years 2 and 10 is $35,753 given the 4% interest rate, far lower than the undiscounted $45,000 discussed above.

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

INTERNAL RATE OF RETURN

The internal rate of return is another way of measuring the worth of investing in education using the same cash flows shown in Table A8.1. 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 A8.1. 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).

44 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.

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.

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.

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.

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 A8.1, 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 9: Shutdown Point

The investment analysis in Chapter 3 weighs the benefits generated by the institutions against the provincial taxpayer funding that the institutions receive to support their operations. An important part of this analysis is factoring out the benefits that the institutions would have been able to generate anyway, even without provincial taxpayer support. This adjustment is used to establish a direct link between what taxpayers pay and what they receive in return. If the institutions are able to generate benefits without provincial taxpayer support, then they would not be a true investment.[45]

The overall approach includes a sub-model that simulates the effect on student enrollment if the institutions lose their provincial funding and have to raise student tuition and fees in order to stay open. If the institutions can still operate without provincial support, then any benefits they generate at that level are discounted from total benefit estimates. If the simulation indicates that the institutions cannot stay open, however, then benefits are directly linked to costs, and no discounting applies. This appendix documents the underlying theory behind these adjustments.

PROVINCIAL GOVERNMENT SUPPORT VERSUS STUDENT DEMAND FOR EDUCATION

Figure A9.1 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-load equivalents (FLEs) and expressed as a percentage of the institutions' current FLE production. Current student tuition and fees are represented by p', and provincial government support covers C% of all

FIGURE A9.1

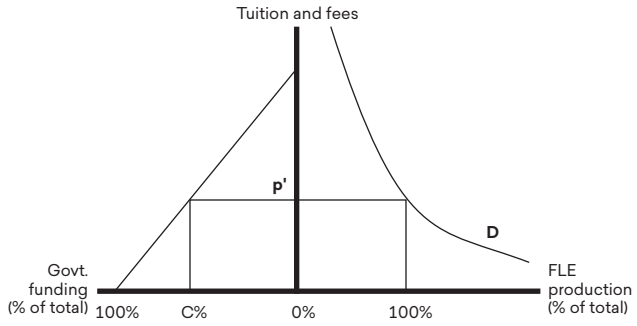
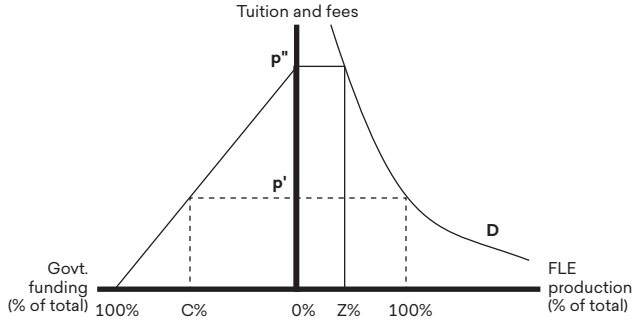


FIGURE A9.2



costs. At this point in the analysis, it is assumed that the institutions have only two sources of revenues: 1) student tuition and fees and 2) provincial government support.

Figure A9.2 shows another important reference point in the model—where provincial government support is 0%, student tuition and fees are increased to p", and the FLE production is at Z% (less than 100%). The reduction in FLEs 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 institutions' 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 institutions can provide absent provincial government

45 Of course, as public training providers, Calgary PSIs 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 Calgary PSIs 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 them.

support, represented as Z% of the institutions' current FLE production in Figure A9.2.

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 FLEs produced. For consistency with the graphs in this appendix, B is expressed as a function of the percent of the institutions' current FLE 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 A9.2. 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%)

CALCULATING BENEFITS AT THE SHUTDOWN POINT

Postsecondary institutions 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 A9.3 as S%. The location of point S% indicates that the institutions can operate at an even lower enrollment level than Z% (the point at which the institutions receive zero provincial government funding). Provincial government support at point

FIGURE A9.3

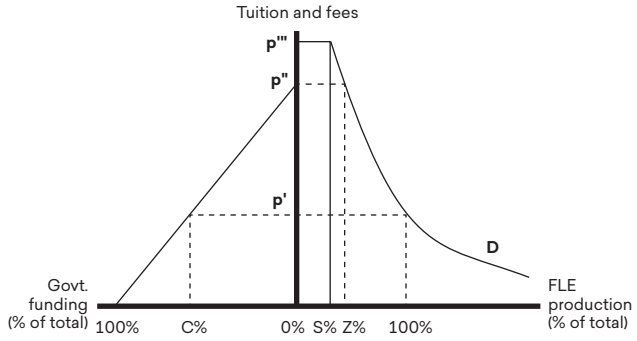
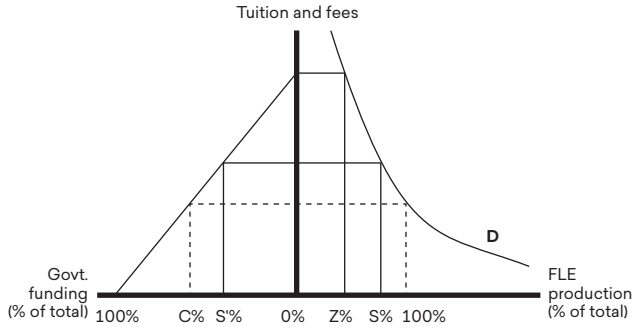


FIGURE A9.4



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 institutions would no longer be able to attract enough students to keep the doors open, and it would shut down.

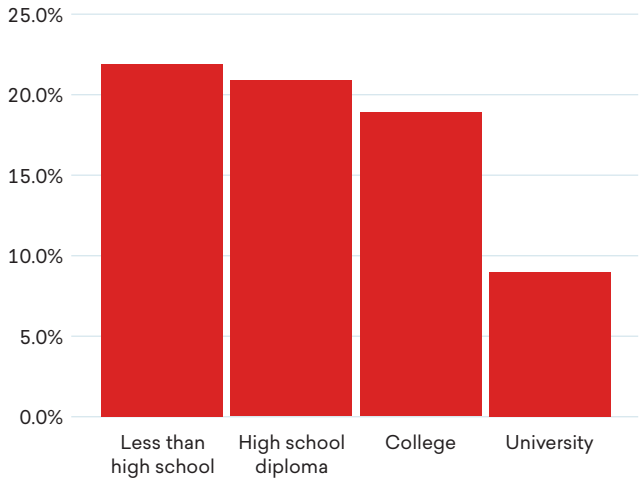
Figure A9.4 illustrates yet another scenario. Here the shutdown point occurs at a level of FLE production greater than Z% (the level of zero provincial government support), meaning some minimum level of provincial government support is needed for the institutions to operate at all. This minimum portion 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 institutions' FLE production, or B = B (100%).

Appendix 10: 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 taxpayers. 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.

FIGURE A10.1: Prevalence of smoking by education level



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.

Smoking

Figure A10.1 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.

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, 17.7% of Alberta's adults were smokers in 2011, relative to 17.3% for the nation. We thus apply a scalar of 1.0 to the national probabilities of smoking in order to adjust them to the province of Alberta.

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 A10.2 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 Centre 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 25.2%

FIGURE A10.2: Prevalence of heavy drinking by sex and education level

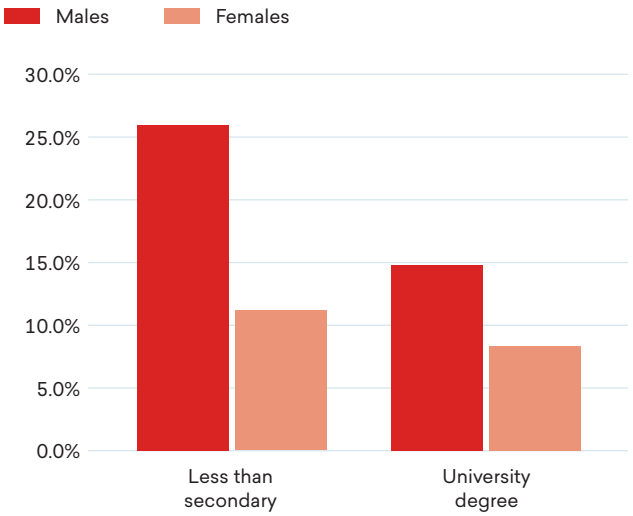


FIGURE A10.3: Prevalence of obesity by education level

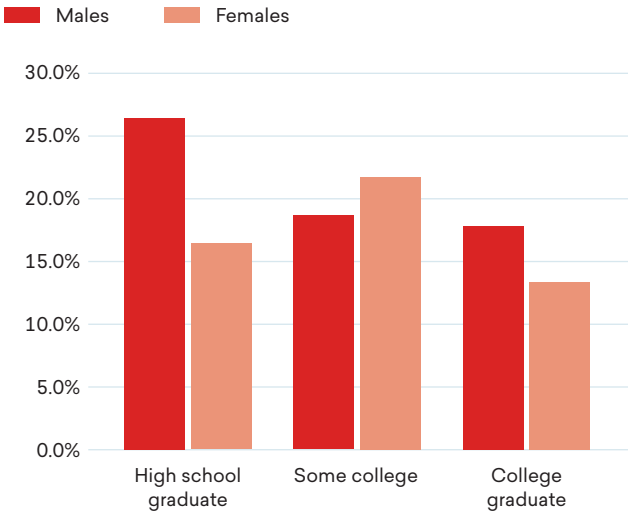
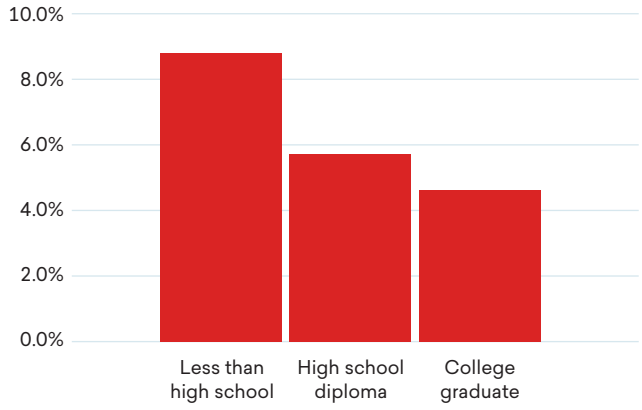


FIGURE A10.4: Prevalence of fair or poor mental health by education level



prevalence rate among males at a less than secondary level to a 19.1% prevalence rate among males with a university degree. Similarly, heavy drinking among females ranges from a 10.7% prevalence rate at the less than secondary level to an 8.1% prevalence rate at the university degree level.

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.[46]

Figure A10.3 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, university 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.

Mental illness

The economic burden of mental health problems in Canada includes the cost of treatment and lost productivity in the workplace. Figure A10.4 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 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.

46 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.

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 A10.5: Percent of adult population that are in custody by education level

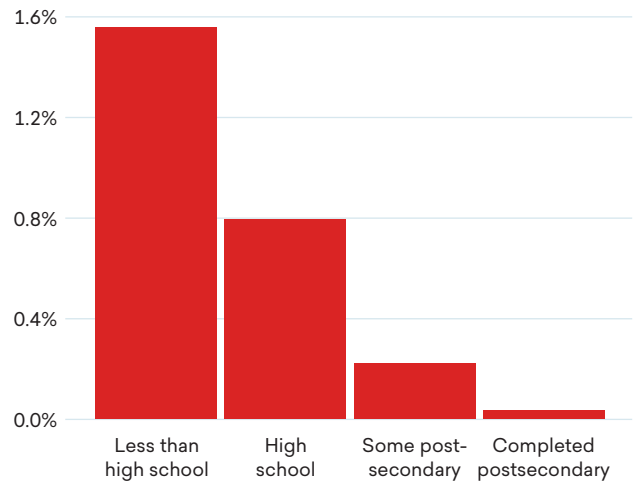


FIGURE A10.6: Unemployment rates by education level

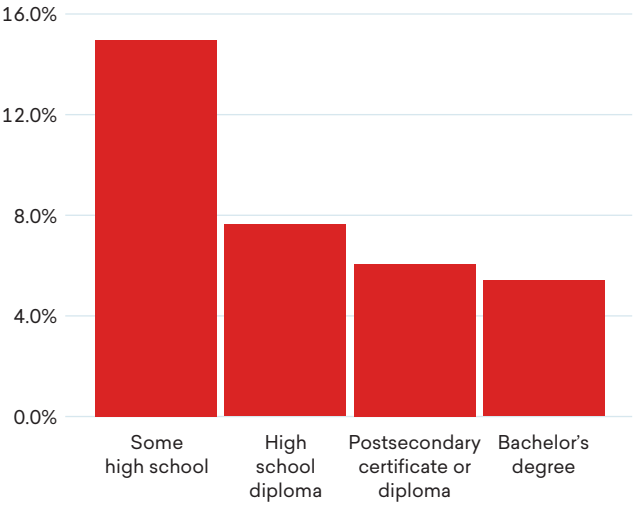


Figure A10.5 displays the probability that an individual will be placed in custody by education level. Data are derived from the breakdown of adults in correctional services by province as provided by combined data from Statistics Canada and the Canadian Centre for Justice Statistics, divided by the total adult population. As indicated, the probability of being placed in custody drops on a sliding scale as education levels rise.

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.

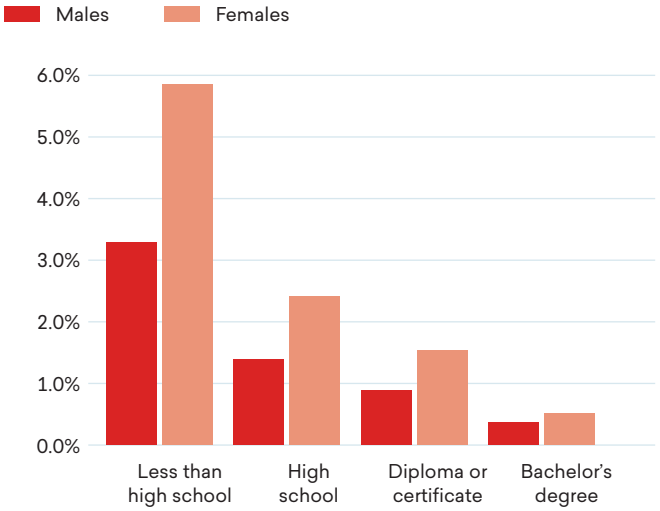
Yet another measurable benefit is the added economic productivity of people who are now gainfully employed, all else being equal, and not in custody. The measurable productivity benefit is simply the number of additional people employed multiplied by the average earnings of their corresponding education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

INCOME ASSISTANCE

Statistics show that as education levels increase, the unemployment rate declines, as shown in Figure A10.6. These data are supplied by the Statistics Canada Labour Force Survey (LFS). Unemployment rates range from 15% for those with less than a high school diploma to 5% for those at the bachelor's degree level.

Figure A10.7, on the next page, 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 A10.7: Probability of claiming employment-related social assistance by gender and education level



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.