Economic Impact Analysis: Dalhousie University

Prepared for:

Dalhousie University

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Key Findings

Dalhousie University generates substantial economic impacts in the Nova Scotia economy, with total GDP impacts of $1 billion, total employment impacts of 10,380 FTEs and total tax impacts of $243 million, based on total direct expenditures in 2009/10.

Dalhousie University's students and visitors support local businesses, and generate sizeable economic impacts through their direct expenditures. In 2009/10, Dalhousie students spent over $88 million (over and above their direct university-related expenditures) and visitors to the university spent an additional $15 million in the local Halifax economy.

In addition to the standard static economic impacts resulting from university-related expenditures, Dalhousie generates substantial dynamic economic impacts resulting from the retention of higher educated persons in the provincial economy. These impacts result not only from increased marginal tax impacts associated with incremental earnings of its alumni, but substantial socio-demographic impacts related to proportionate increase in the university-educated working-aged alumni, reduced health care costs, increased capacity for savings and asset accumulation, higher incomes during retirement, decreased reliance on Old Age Security benefits, and labour force impacts resulting from the retention of highly qualified persons (HQPs) in Nova Scotia.

The estimated average annual income tax impact attributable to the incremental earnings Dalhousie alumni retained and employed in the province is $71.4 million per year for the Province of Nova Scotia.

Dalhousie University is a major contributor to a higher educational attainment in the local economy. Almost one quarter (24%) of the working age population in Halifax has completed a university degree at least at the bachelor's level, well above the province-wide (16%) or Canada-wide (18%) levels.

The average annual incremental earnings in the Nova Scotia labour force between those with a bachelor's degree and those without is $18,783 and $36,953 between those above a bachelor's and those below bachelor's level.

The cumulative value of earnings differentials associated with level of education over one's lifetime is substantial. The net present value of the incremental lifetime earnings in the Nova Scotia labour market associated with a bachelor's degree is roughly $277 thousand and $667 thousand for a degree higher than the bachelor's level.

Higher Education is linked to lower health care costs: *Dalhousie University through its contribution to improved higher education and its impact on socioeconomic health outcomes provides an estimated savings of $33 million annually in health care costs in Nova Scotia.*

Higher Education Leads to Greater Savings and Assets: *Median net assets among university graduates are $128,000 higher than for those holding a high school degree.*

Higher Education Contributes to Higher Income During Retirement: The median income for seniors holding a university degree ($48,000) is more than double the median income ($21,000) for all seniors (all levels of education).

Seniors With Higher Levels of Education Rely Less on Old Age Security (OAS): *Roughly 44% of all OAG/GIS benefit payment are made to seniors that do not hold a diploma and almost 30 percent to those with a high school degree*

Higher Education Reduces Risk of Unemployment: *University degree holders had one-third the risk of experiencing unemployment (4%) than those with no high school diploma (12.3%) in Canada in 2006.*

Dalhousie plays a major role in the commercialization of research and innovation in Nova Scotia with its ILI office contributing to commercialization funding commitments of more than $4.5 million in 2009-10.

Dalhousie University plays a pivotal role in the province's R&D efforts, and is a prime mover in its knowledge economy. Dalhousie's research centres receive federal funding and national recognition as centres of research excellence, providing world-class research capacity leading to innovation and serving as a catalyst for progressive growth.

Introduction

This study provides a comprehensive analysis of the economic impacts in the provincial economy associated with the education and research activities of Dalhousie University. It addresses a gap in understanding the nature and scope of the full economic impacts associated with the knowledge creation and transmission aspects of university activities that fundamentally alter the capacity for economic growth for an economy.

- The static economic impact analysis associated with direct expenditures made by universities, their employees, students and visitors has already been well documented using a standard input-output analysis. However, the economic impact of a university is unlike any other organization in that it is not only comprised of the impacts resulting from university-related direct expenditures made in the local or provincial economy. Universities generate ongoing 'dynamic' impacts in an economy as a result of their education and research activities, producing substantial longer-term economic impacts. These dynamic impacts are a derived as result of the positive linkages between higher education and increased economic well-being associated with the retention of highly qualified persons (HQPs) in the economy.

Post-secondary education plays a major role in the achievement of high levels of economic growth and development, and to the realization of the broader quality of life and economic wellbeing benefits associated with it.

The retention of Dalhousie graduates (originating from outside the province) in the provincial economy contributes to an increased population of highly qualified persons (HQPs) attracted and retained in the provincial economy workforce, as well as the socio-demographic impacts associated with a higher educated population.

Describing and quantifying the linkages between Dalhousie University education and research activities and the resulting longer-term dynamic economic impacts provides the basis for a greater understanding of the economic contribution and value the economy and its communities derive from the existence of Dalhousie University.

In addition to the traditional approach to measuring economic impacts based on the direct expenditures made in the local economy and direct employment of the university, this study also examines the dynamic longer-term economic impacts Dalhousie University has on the provincial economy through its contribution to the retention of graduates and the socio-demographic benefits resulting from a higher educated population.

This report assesses the impact of the education and research activities of Dalhousie University using a combination of a standard approach ·to economic impact analysis using Statistics Canada's Input-Output (I-O) model as well as a dynamic approach to measuring the longer-term socioeconomic impacts associated with the retention of Dalhousie graduates in the Nova Scotia economy based on current research results and Statistics Canada data.

A review of the relevant literature and aggregate evidence on the economic impacts associated with a greater educated population is utilized, in conjunction with Dalhousie University and Statistics Canada data to provide an assessment of the on-gong and long-term economic impacts attributable to Dalhousie University.

The economic impacts associated with Dalhousie University are assessed and estimated for the following dimensions:

1. Direct, indirect and induced impacts resulting from direct expenditures in the economy associated with Dalhousie University education and research activities.
2. The fiscal impact of a university educated workforce, including the marginal tax benefits accruing as a result of the incremental earnings associated with Dalhousie alumni retained and employed in the provincial economy.
3. An analysis of the proportion of Dalhousie graduates originating from outside Nova Scotia retained in the local economy, as well as the estimated total number of Dalhousie alumni living and employed in the province.
4. An assessment of the socio-demographic and resulting economic impacts associated with a higher educated population attributable to Dalhousie University, including.
   - increased earnings capacity;
   - increased tax impacts;
   - decreased risk of unemployment
   - increased labour force productive capacity;
   - reduced health care costs;
   - increased capacity for asset accumulation;
   - increased retirement savings;
   - increased retirement income; and
   - decreased reliance on Old Age Security (OAS) benefits.

Context

Dalhousie is a comprehensive teaching and research university, offering 175 programs to nearly 17,000 undergraduate, professional and graduate students. The university's research capacity attracts more than $130 million in external research funding annually. Research expertise includes Ocean Science and Health and Medical Science, with a growing involvement in advanced technical research and education. Dalhousie is building research expertise in important fields, including materials science, neuroscience, biotechnology, genomics, architecture, environmental research, information management, health law, finance, foreign policy, and biomedical engineering.

The "Report on the University System in Nova Scotia"[1], recognized Dalhousie as being the largest university with the most comprehensive array of graduate and professional programs, not only in Nova Scotia, but in the Atlantic region. A distinguishing characteristic of Dalhousie is that it is the only university in the province that offers degrees in medicine, law, pharmacy, dentistry, allied health professions, engineering, and oceanography.

Operations

The following provides a detailed account of Dalhousie University's expenditures, economic impacts, and role in supporting local and regional development. Information for this report was gathered from Dalhousie University and Statistics Canada sources.

- **Operations: $600 million** – spent by Dalhousie University on operations in fiscal 2009/10, including $302 million on salaries and benefits, and $298 million on a wide range of other goods and services.
- **Employment: 5,750 full-time and part-time faculty and staff** employed (4,450 full-time equivalents (FTEs).
- **Income: $302 million** – spent by Dalhousie University on wages and salaries, including benefits.
- **Construction: $75 million** – invested in 2010 by Dalhousie University for new and renovated facilities to improve education services and to foster greater research capability.

[1] O'Neill, T. "Report on the University System in Nova Scotia", prepared for Province of Nova Scotia, September 2010. P. 138.

Economic Impacts of Direct Expenditures

The analysis captures the impacts of university expenditures, including impacts arising from student and visitor expenditures as well as research expenditures. Economic impacts are measured using conventional indicators: Gross Domestic Product (GDP), employment and labour income and tax revenue generated.[2] All values are in 2009-10 dollars, based on 2009-10 expenditures and employment.

- **Gross Domestic Product (GDP): $1 billion** – total value of local economic activity (excluding imports from other provinces or countries).
- **Employment: 10,280 Full Time Equivalents (FTEs)** – for every FTE created in the university, 1.3 additional FTEs are created in the economy.
- **Income: $596 million** – in wages and earned elsewhere in the economy as a result of university expenditures.
- **Tax revenue**: **$243 million** – total personal and indirect taxes collected by the federal and provincial governments based on direct expenditures.

Student and Visitor Impacts

The estimated total economic impact (above) includes the direct expenditures made by students and visitors to Dalhousie University. These expenditures include the off-campus portion of their expenditures, and do not include payments to the university for tuition, books, food, or housing to avoid double counting of expenditures. For students living in on-campus housing, the bulk of their expenditures flow to the universities and is already captured in the university expenditures in providing its educational and research services.

Visitors to Dalhousie (including those attending convocations and conferences, conducting business with the universities, attending major sporting and arts events, visiting researchers, scholars, and lecturers) also contribute to the local economy. An estimated $88 million was spent by Dalhousie students (in addition to their direct expenditures on tuition, books, on-campus housing, and other university fees) and an estimated $15 million spent by visitors in the local economy in 2009/10.

[2] The Statistics Canada Interprovincial Input-Output model is used to estimate economic impacts.

Valuing post-secondary education

Post-secondary education plays a major role in the achievement of high levels of economic growth and development, and to the realization of the broader quality of life benefits associated with it. Recognizing this, Canada's federal and provincial governments invest billions of dollars annually to support post-secondary institutions in Canada. Economies with higher educational attainment have a greater probability of attracting and retaining businesses to their local economy. A more educated workforce is more likely to have an increased capacity to be innovative, develop technologies and processes (leading to increased productivity) - as well as a greater capacity to receive and apply new technologies.

- Dalhousie is a major contributor to the significantly higher educational attainment of the labour force in the local economy. The university supplies thousands of graduates each year in professions that provide the critical underpinnings for economic growth, diversification and innovation.
- Almost one quarter (24%) of the working age population in Halifax has completed a university degree at least at the bachelor's level.
- The 2006 Census data shows that the average annual earnings differential in the Nova Scotia labour force between those with a bachelor's degree and those without is $18,783 and $36,953 between those above a bachelor's level and those below a bachelor's level.[3]
- The cumulative value of these earnings differentials over one's lifetime is substantial. The present value of the incremental nets earnings associated with a bachelor's degree over a 40-year income stream is estimated to be $277 thousand dollars and $667 thousand dollars for a degree above the bachelor's level (adjusted for the cost of university and foregone earnings while in university).
- The cumulative value of the incremental net earnings associated with a university educated workforce generates substantial tax impacts for the provincial economy.
- The estimated present value of the total tax impacts for the province of Nova Scotia attributable to the incremental earnings of Dalhousie alumni over a 40-year working lifetime is estimated to be $2.86 billion based on the total number of Dalhousie alumni that are retained and employed in the Nova Scotia economy in 2010 as well as the nature of the degrees they hold.[4]
- This translates into an average annual tax impact of $71.4 million per year for the Province of Nova Scotia attributable to the incremental earnings of Dalhousie alumni currently retained and employed in the provincial economy.
- Dalhousie students originating from outside the province and retained in the provincial economy upon graduation, represent an annual net increase in population and a substantial contribution to the economic wellbeing of the province.
- A more educated workforce is more likely to have a greater capacity to develop technologies and innovative processes (resulting in increased productivity) and to have greater capacity to receive and apply new technologies (receptor capacity).
- While the socio-demographic impacts of investment in education are generally omitted in assessing the economic impacts of education, the results of the literature indicate that these effects are large and should be considered to correctly evaluate the optimum level of investment in education.

Impact of Dalhousie's R&D expenditures

Dalhousie University occupies the central role in conducting R&D in the Region. The university's research, training and innovation reflect areas of importance to the region and globally.

- Knowledge dissemination: Dalhousie ranks extremely high in science and engineering publication citations, with a total of 36 Dalhousie faculty members having more than 2,000 journal citations each.
- Among Canada's largest 25 universities, Dalhousie has the largest number of research citations per dollar of research income received and the only university within the top five universities with a medical faculty.
- Dalhousie is part of a select group of 17 universities in Canada with a medical faculty.

[3] Earnings differentials are based Census 2006 data, expressed in 2010 dollars Canadian.

[4] Analysis based on a discount factor of 3 percent.

Research and Development (R&D)

Dalhousie University, with eleven Faculties and eighty academic departments, constitutes the largest comprehensive, research-intensive academic institution in Atlantic Canada. The university occupies a pivotal role in the knowledge economy for the province of Nova Scotia and Canada as a whole.

- Dalhousie University plays a major role in performing basic and applied research fundamental to innovation, economic growth and diversification.
- Dalhousie is consistently named among Canada's top research universities.
- The University holds 47 Canada Research Chairs (CRC), closely following University of Manitoba (50) and Queens University (54).
- Dalhousie has built extensive capacity for the local and provincial economy through a diverse range of relevant research programs and activities that reinforce a cooperative, collaborative and interdisciplinary approach to research and education. These processes have fostered research partnerships with regional, national, and international Universities, affiliated teaching hospitals (IWK and QEII), governments and industry.
- Health Science and Ocean Science remain long-standing areas of research strength and special emphasis at Dalhousie University. The university has developed an extensive Ocean Science research program that involves more than 100 researchers in 6 faculties, and a wide array of disciplines.
- Health and Medical Science encompasses the largest area of research at the University and in collaboration with the affiliated teaching hospitals (IWK and QEII), represents 60% of external research funding and the activities of over 500 faculty members.
- Dalhousie has established expertise in ocean science research, with the 2009 award of $45 million from the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Canadian Foundation for Innovation (CFI) to establish the Ocean Tracking Network and $10 million to establish a Canada Excellence Research Chair in Ocean Science and Technology.
- The Life Science Research Institute (LSRI) was established as a centre of excellence focusing on research and commercialization.
- The LSRI complex will house Dalhousie's life-sciences-focused research, including the Brain Repair Centre and the Innovacorp BioScience Enterprise Centre. The LSRI offers significant potential for partnerships between researchers and business and a site for incubating business ventures resulting from this collaboration.
- The ocean-related research programs at Dalhousie and other local organizations will come together under the new Halifax Marine Research Institute, moving Dalhousie to the forefront of ocean studies worldwide. The collaborative approach of the new Institute of Marine Sciences offers the potential to serve as one of the key economic drivers of the region generating extensive cooperation across disciplines and among institutions -- within Canada and around the world.

Innovation and Commercialization

Leading research organizations, including the Rockefeller Institute, have concluded that universities have become the real incubators of success in North America's knowledge economy. University research is recognized as being the driver of growth of the knowledge economy, which has become vital as the manufacturing sector's competitive position declines in both Canada and the United States.

- The impact of university research and development expenditure doesn't end with knowledge creation or dissemination. The economic value is developed when business opportunities arise as a result of translating the research into results.
- Dalhousie's Industry Liaison and Innovation (ILI) office plays an important role in bridging the gap between the lab and the boardroom and translating innovation into new market-based opportunities.
- The ILI office directly contributed to commercialization funding commitments of more than $4.5 million in 2009-10.
- Dalhousie has supported efforts at other Springboard member institutions and national organizations such as MARS (BioDiscovery), the Ontario Research Excellence Awards and the recent Centres of Excellence for Commercialization and Research competition. Dalhousie also led a successful funding effort for the Springboard network in 2008 in the amount of $8.5 million.

I
INTRODUCTION

Dalhousie University is one of the Region's oldest and largest universities, offering undergraduate and graduate programs in all major disciplines, as well as professional programs in medicine, law, dentistry, pharmacy, health professions, engineering and architecture. Dalhousie ranks as a leading research institution in Canada (based on total research funds, the growth of collaborative research in medical and scientific research, research citations), with concentrations in such areas as health/medicine (concentrating in neuroscience, cancer, cardiovascular systems and infectious diseases), marine biosciences and materials science. Dalhousie University and its affiliated teaching hospitals constitute the largest, comprehensive, research-intensive, academic organization in Atlantic Canada with eleven faculties and eighty academic departments.

Dalhousie University:

- educates nearly 17,000 students annually;
- attracts over half of its students from outside the province;
- employs 5,750 full-time and part-time faculty and staff;
- generates annual expenditures in the range of $600 million; and
- attracts research funding of over $130 million.

Many people think of universities simply as institutions providing post-secondary education and conducting research. While these are clearly their primary functions, the nature of their activities and scope of their influence extend well beyond the campus and into the provincial economy. In addition to facilitating and supporting economic and social growth and development, universities play a direct role in generating economic activity in their communities and regions. They do this through the millions of dollars spent annually in operating their facilities, and in constructing new buildings. They also do this by generating employment for faculty and staff, who in turn spend their incomes in the local community.

Dalhousie University makes a substantial impact on the economic and social fabric of the local community within Halifax Regional Municipality (HRM) and the province as a whole. This impact is measured in terms of its large share of employment, disproportionately high contribution to community income, high retention of university graduates working in the local economy, its net positive socio-demographic impact on population and substantial contribution to the tax base of the provincial economy.

- Dalhousie University conducts basic and applied research, providing the foundation for innovation in products and processes across a wide spectrum of areas including health science, oceanography, bioengineering, life sciences, new materials, other sciences, social sciences and engineering. Research results in the creation of new knowledge, new discoveries, new applications and opportunities for commercialization, new business venture creation, and the attraction of new companies to the local economy. Discoveries lead to economic growth, social development and improved health outcomes.

- Dalhousie graduates go on to supply the local, regional, national and international economies with the human capital they need to innovate, grow and diversify. Dalhousie has graduated 85 Rhodes Scholars, the most from any university in the region, and 6th most in the world.[5]
- Dalhousie University serves as a focal point for the performing and visual arts, for debate on emerging issues, and for athletic activities, thereby enriching the lives of all in the community which it serves.
- Dalhousie University delivers a wide range of continuing education programs, a vital resource to meet the demands for life-long learning in the knowledge economy.
- Dalhousie extends its reach into the developing world, providing assistance in addressing health, scientific, environmental and resource management issues.

The economic impacts of expenditures by universities, their employees, and their students already have been well documented using standard input-output analysis. However, the economic impact of a university is unlike any other organization in that in addition to the standard "static" impact on the local or provincial economy resulting from the direct university-related expenditures in the local economy, a university also generates "dynamic" impacts resulting from the retention of highly qualified persons (HQPs) in the local economy, potential net positive socio-demographic impacts on population, knowledge creation, and knowledge transmission aspects of its activities.

The main aim of this study is to produce a comprehensive analysis of the economic impact associated with Dalhousie University in the local and provincial economy. It is intended to address a major gap in public understanding of the nature, scope and impact of university activities. Describing and quantifying the linkages between Dalhousie University activities and economic impacts provides a basis for a greater understanding of the value the economy and its communities derive from university education and research activities.

This study estimates the economic impact of Dalhousie University using a combination of a standard approach ·to economic impact analysis using Statistics Canada's Input-Output (I-O) model as well as current research results from the literature examining the linkages between higher education and improved socioeconomic outcomes, including the development of a highly qualified labour force, increased capacity for retirement savings, lower reliance on public pension funds, decreased health care costs, increased earnings and marginal tax impacts, decreased risk of unemployment and periods of low income, and the impact of knowledge creation and knowledge transmission on economic growth and wellbeing.

This report assesses the impact of the education and research operations of Dalhousie University in its entirety, measuring the economic impact on the provincial economy as a result of the university-related expenditures (including student, employee, visitor, and construction expenditures) along with the economic impacts associated with the retention of Dalhousie graduates in the provincial economy, a higher educated workforce, research and knowledge creation generated by the presence of a research university, as well as the socio-demographic impacts of increased population of highly qualified persons (HQPs) attracted and retained in the provincial economy, outlining the theory and evidence that these are real and important economic impacts.

[5] Only Harvard, Yale, Princeton, McGill, and the University of Toronto have more.

As a result, the economic impact associated with Dalhousie University is assessed and estimated for the following dimensions:

1. Direct impacts associated with Dalhousie University direct expenditures remaining in the local economy;
2. Induced impacts; spending which is non-university, but would 'not occur without' the university;
3. The impact of a university educated workforce, including the fiscal impact of marginal tax benefits accruing due to earnings differentials associated with the average incomes of Dalhousie university graduates retained in the provincial economy;
4. An assessment of the socio-demographic and resulting economic impacts associated with a higher educated population attributable to Dalhousie University. This discussion illustrates the substantial net positive impact on Nova Scotia's population directly attributable to Dalhousie University, including:

    - increased earnings capacity;
    - increased marginal tax impacts;
    - decreased risk of unemployment;
    - decreased risk of periods of low income;
    - increased labour force productive capacity;
    - increased capacity for asset accumulation;
    - increased retirement savings;
    - increased retirement income;
    - decreased reliance on Old Age Security (OAS) benefits; and
    - reduced health care cost.

5. The impact of new knowledge created by and facilitated by the university.

The last three of these channels of economic impact are not easily measurable. A review of the relevant literature on the socio-demographic impacts of increased population of a greater educated workforce, as well as the impacts associated with research and knowledge creation is provided. The theory and aggregate evidence is utilized, in conjunction with Dalhousie University and Statistics Canada data to provide an assessment of the economic impact of the educational and research activities of Dalhousie University.

This study shows that in addition to the economic impacts resulting from sizeable direct expenditures associated with Dalhousie University education and research operations, its students, employees and visitors in the local economy, the education and research services provided by Dalhousie provides a substantial net positive impact on the socio-demographic composition and the productive capacity of the economy (at the local, provincial, and national level). This study examines the economic impacts generated as a result of the retention of Dalhousie university graduates in the provincial economy. A portion of this value is measured as the marginal fiscal impacts associated with the incremental earnings of Dalhousie graduates working in the province. In addition, the net positive impact on the socio-demographic composition as a result of an increased university-educated population generates substantial impacts to the provincial economy in an increased capacity for savings for retirement, increased retirement income, decreased reliance on Old Age Security (OAS) benefits, and decreased health care costs. This report provides a brief summary of the results and findings of recent Statistics Canada data as well as current research findings related to the economic returns to post secondary education attainment and the contribution to economic-wellbeing in the Canadian context.

1. REPORT LAYOUT

Following this introduction, Chapter II sets out an overview of Dalhousie university expenditures in the local economy, providing the reader with a snapshot of the expenditures and research funding as well as employment.

Chapter III assesses the economic impact of Dalhousie University based on the direct expenditures on goods and services that remain in the provincial economy to support it operations, construct new facilities and carry out its educational and research functions. Direct employment and income are quantified and assessed in the context of the university communities, highlighting the relative importance of Dalhousie as an institution. This chapter also provides estimates of the economic impacts associated with the additional spending attributable to students (over and above their payments to the university) and visiting scholars and researchers, and parents and visitors from outside the Region.

Chapter IV provides a breakdown of domestic and international student enrolment and an analysis of the origin of students. An examination of the economic impacts associated with student off-campus and visitor direct expenditures in the local economy is also provided. Visitors spending include the expenditures made by visiting academics, scholars, researchers, friends, and family directly attributable to Dalhousie activities and events.

Chapter V provides an analysis of the economic impacts generated as a result of the retention of Dalhousie university graduates in the provincial economy. This value is measured as the marginal fiscal impacts associated with the incremental earnings of Dalhousie graduates working in the province, in addition to the net positive socio-demographic impacts to the provincial economy resulting from an increased university-educated population and the productive capacity of the provincial economy. This analysis provides an assessment of the economic impacts associated with an increased capacity for retirement savings, increased retirement income, decreased reliance on Old Age Security (OAS) benefits, and decreased health care costs attributable to the retention of Dalhousie graduates in the provincial economy.

Chapter VI examines the economic value of Dalhousie as a producer of knowledge (in the form of graduates and research results) leading to innovation, greater productivity and growth in GDP. This chapter takes a close look at Dalhousie University research and its relationship to innovation and economic growth. This chapter also explores some of the challenges in measuring the economic impact of research, in particular the implications for innovation of conducting research.

Chapter VII provides a summary of the key research activities and results emerging from the research undertaken by Dalhousie University or in collaboration with the key hospital research units (IWK and QEII), the provincial or federal government, or research institutions within Halifax Regional Municipality (HRM). This discussion illustrates the nature and scope of the collaborative nature and research capacity building benefits derived from the research undertaken by and attributable to Dalhousie University.

Chapter VIII examines the impacts of innovation and commercialization as a result of Dalhousie's research activities and its contribution to the growth of the knowledge economy.

Chapter IX contains the key findings and conclusions.

II
UNIVERSITY EXPENDITURES

1. OVERVIEW

Dalhousie University spends well over half a billion dollars per year (600 million in 2009-2010), based on their direct expenditures for wages and salaries, operations and maintenance, and a wide range of products and services they require. These expenditures support jobs and income both on campus and elsewhere in the local and regional economy. Further economic impacts arise from spending by students and visitors on goods and services from merchants and service providers in the community.

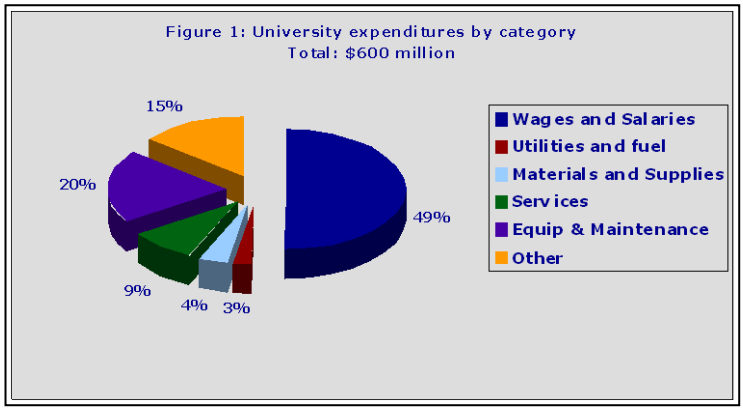
The analysis focuses primarily on the immediate economic impact of these expenditures, but will also include the additional economic benefits to the provincial economy related to additional direct expenditures of students, as well as visiting researchers, scholars, friends and family directly related to Dalhousie University education and research activities. The economic impacts resulting from direct expenditures on R&D activities are also discussed. The immediate impact refers to just the spending effects, not the broader and longer-term economic impacts resulting from increased knowledge. The knowledge impacts of the university results from the impact of research and development, innovation on the growth rate of GDP, as well as the impact of the entry of graduates into the workforce where they influence productivity and innovation. These broader longer-term economic impacts resulting from increased knowledge are presented further in this report.

The data to support this analysis and the resulting impact estimates are drawn from Dalhousie University, the Maritime Provinces Higher Education Commission (MPHEC), Canadian Association of University Business Officers (CAUBO), and Statistics Canada. A breakdown of operating and capital expenditures according to specified categories, employment figures for full- and part-time faculty and staff, as well as detailed information on student enrolment by level, full-time and part-time status, and origin is provided by Dalhousie University.

2. EXPENDITURE CATEGORIES

Wages and salaries represent the largest expense

The $600 million in university expenditures (Figure 1) is mainly comprised of: wages and salaries (49%), equipment and maintenance (20%), other expenses (15%), and services (9%). The main operational expenditures (wages and salaries) and capital expenditures (building and land development) are described further in sections below.



Though most purchases are made from local (provincial) sources, the import content of the products varies widely.

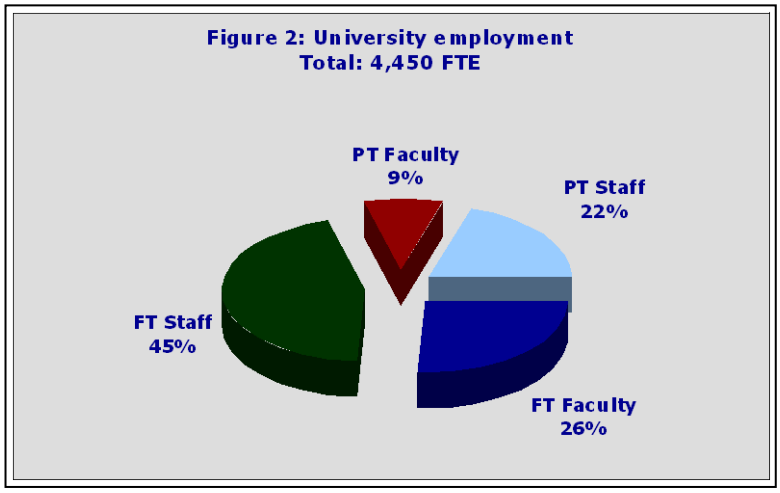
- Among the goods and services with ***high local content*** are utilities, communications, engineering services, maintenance and food service. These have a greater impact on local economies.
- The goods and services with ***high import content*** tend to be specialized items, often purchased in limited quantities including laboratory equipment, computers, text books, insurance and travel services. These have reduced impacts on local economies.

Within the "other" category the largest item is scholarships, bursaries, and prizes, but the category also includes other operational expenditures, interest payments, and costs associated with goods sold by the university.

3. EMPLOYMENT AND INCOME

Dalhousie generates substantial employment in local community

Wages and salaries represent the largest operational expenditure. Dalhousie University employs 5,750 faculty and staff (or 4,450 full-time equivalent (FTEs)[6] comprised of 3,150 full-time and approximately 1,300 FTEs). In addition, several hundred students not included in these figures are employed as researchers, teaching assistants and demonstrators, and serve in other support roles. Figure 2 provides a breakdown of employment by full-time and part-time faculty and staff (2008/09). Another meaningful way to understand the relative importance of the university as an employer in the economy is to compare it with other key industries. The figures in Table 1 indicate that Dalhousie is a significant employer, comparable in size not just to other single employers or companies but comparable to entire leading industries or sectors.



- Dalhousie University employs more than the provincial government does in HRM.
- Dalhousie University employs just over half the number of provincial government employees in the whole province.

[6] Part-time faculty and staff were assigned 0.5 full-time equivalents based on methodology applied to all Atlantic Canada universities in *The Economic Impact of Universities in the Atlantic Provinces – The current view 2006-2008*, Atlantic Association of Universities (AAU), May 2010

- Dalhousie employment is significant when compared as a percentage to employment for other key sectors in HRM such as: the federal government (73%), wholesale trade (51%), finance and insurance (47%), and manufacturing (40%).

Table 1:
Employment levels - Dalhousie University vs. other sectors (2009/10)

	Halifax	Province
Dalhousie University	**4,450**	**4,450**
Manufacturing	11,015	37,228
Wholesale trade	8,630	17,410
Finance & insurance	9,310	14,968
Federal government	6,105	12,870
Provincial government	4,370	9,314

Source: Statistics Canada and Dalhousie University

University income impact reflects high average salaries

The Dalhousie University total payroll (salaries and benefits) in 2009/10 amounted to about $302 million. Virtually 100% of this was paid to residents of the Halifax Regional Municipality.

University faculty and staff tend to be paid above the average incomes in their community. This reflects not only the additional investment faculty make in order to earn advanced degrees, but also the fact that universities have to compete to attract academics who combine the highest standards of teaching and research. Consequently, the university payroll creates an economic impact on local economies that exceeds substantially the relative employment impacts. This is evident by comparing the impact percentages for employment (2.2% of HRM) and incomes (3.6% of HRM), where income percentages are higher. This is consistent with other university communities, since the income of faculty and staff is typically one-third greater than the average in their communities.

Universities represent not only a generator of high-paying jobs, but also highly stable jobs:

- Unlike many enterprises in the regional economy, universities tend to be less vulnerable to the swings in the business cycle. For instance the Atlantic Region experienced considerable job losses over the last decade as competitive forces resulted in corporate consolidations, while universities have remained stable or have grown.

- University jobs are valuable as well because most are full-year and full-time. This may seem like a minor consideration to many observers who believe the vast majority of jobs in urban centres are full-year and full-time. But this is not the case. The 2006 Census data show that in the Atlantic region *only 49% of those reporting earned income held full-time jobs that lasted a full year.*

4. CONSTRUCTION

Development of buildings and land represents the largest capital expenditure for universities. Dalhousie University invested in facilities renewal with a budget allocation of $75 million in 2009-10. Numerous major projects were completed over this time period with upgrades in building systems and structures, accessibility, safety, and redevelopment of campus space. This includes classroom renovation (Dentistry and Law), improvements to exterior spaces (LSC to Sheriff Hall), transformer replacement (Killam) and roofing projects (Dunn). In addition, two new buildings commenced construction on Dalhousie campuses; the Mona Campbell Building, a 100,000 square foot classroom and office building (completed fall of 2010) on Coburg Road, and the Life Sciences Research Centre, a 100,000 square foot research and commercialization building scheduled for completion in the spring of 2011 on Summer Street. These investments allow the university to respond to three main drivers:

- **Fostering a continually increasing research capability** – to take advantage of increased funding, the university has invested in new facilities and equipment, thereby positioning themselves to play an even stronger role in Canada's innovation agenda. Dalhousie University competes with institutions across Canada and the U.S. both for funds and the top-flight researchers to carry out the work. State-of-the-art facilities form a vital underpinning to success.

- **The need to compete** – in order to maintain a strong competitive position with universities elsewhere in Canada – both for students and faculty – Dalhousie University needed to invest in specialized facilities in such areas as computer science, natural and physical sciences and management.

- **Increasing demand** – with an enrolment growth in 2010 of 61.6% (as compared to 1990-91)[7], particularly among students from outside the Region, there is an increased demand for expanded residential facilities and classroom space.

[7] Enrolment at Dalhousie University has grown from 10,395 in 1990-91 to 16,800 in 2010-11, giving a 61.6 percent increase over this period.

III
ECONOMIC IMPACTS RESULTING FROM DIRECT EXPENDITURES

1. DIRECT SPENDING AND EMPLOYMENT

Spending of $600 million and 5,750 jobs

Direct spending by Dalhousie University amounted to an estimated $600 million and employment of 5,750 jobs (4,450 FTE)**.** Table 2 includes all university spending for: wages and salaries, operations and maintenance, and capital projects. Student spending off-campus for accommodation, food, and other university-related goods and services amounted to $88 million, occurring mostly in Halifax but also extending to other parts of the province. Visiting scholars and researchers as well as friends and family of students spend an estimated $15 million on accommodations, food, and tourism activities in Halifax and surrounding areas. The number of visitors is based on estimates provided by the university, while spending for friends and family is estimated according to Nova Scotia Visitor Exit Survey, and spending for scholars and researchers is based on a two-month average length of stay and monthly spending estimates for food and accommodation.

Table 2:
Dalhousie University direct spending and employment (2009-10)

	$ millions
University expenditures	
Operations	$525
Capital	$75
Total	**$600**
Student off-campus expenditures	
Accommodation	$32
Food	$31
Other	$25
Total	**$88**
Visitor expenditures	
Scholars and researchers	$9
Family and friends	$6
Total	**$15**
Total Direct Expenditures	**$703**
University employment	
Full-time	3,150
Part-time	2,600
Total	**5,750**

Source: Dalhousie University and Gardner Pinfold

2. ECONOMIC IMPACTS

Impacts extend beyond direct employment and income

University spending generates immediate economic activity, and also so-called "spin-off" activity in the wider economy through what is commonly known as the multiplier effect. Economists divide these activities into three categories according to the type of expenditure:

- **Direct** – this captures the impact from university spending on goods and services including the employment of faculty and staff, the income they earn and the taxes they provide to governments. It also captures the increase in economic activity through the purchases required for operations and delivery of academic and research programs.
- **Indirect** – this captures the increase in economic activity occurring elsewhere in the economy in the production of the primary and intermediate goods and services purchased as inputs by suppliers of direct goods and services to the universities. These indirect or inter-industry effects can take weeks or months to work their way through the economy.
- **Induced** – this captures the increase in economic activity in the broader economy resulting from spending of incomes gained by those employed in direct and indirect activities.

Several indicators are commonly used to measure economic impact: gross domestic product (GDP), employment, income and tax revenue. These indicators, and their values for Dalhousie University, are set out below (Table 3).

Table 3:
Economic impact of Dalhousie University related expenditures
(all values in $millions except employment, 2009/10)

Impacts	$ millions / FTE
Gross domestic product	
Direct	$648.1
Indirect	$102.6
Induced	$248.2
Total	**$998.9**
Employment (FTE)	
Direct	6,035
Indirect	1,754
Induced	2,491
Total	**10,280**
Income	
Direct	$361
Indirect	$45
Induced	$189
Total	**$596**
Tax Revenue	
Direct	$171
Indirect	$15
Induced	$57
Total	**$243**

Source: StatCan Input-Output Model

- **Gross Domestic Product (GDP): $1 billion** – GDP is the most widely used indicator of economic activity, measuring the income captured in the economy through the production of the universities' output – knowledge in the form of graduates and research results.
- **Employment: 10,280 full time equivalents (FTEs)** – for every FTE created in the universities, other 1.3 FTEs are created elsewhere in the economy. This flows from the spending by universities that triggers activity amongst suppliers of goods and services and their suppliers, as well as all of these employees spending income to support their households.
- **Income: $596 million in salaries and wages** – wages earned elsewhere in the economy as a result of university spending.
- **Tax revenue**: **$243 million** – total personal and indirect collected by the federal and provincial governments as well as GST, HST and PST as applicable for the fiscal year 2009/10.[8] The total provincial tax impacts are estimated to be $134 million and total federal tax impacts are estimated to be $109 million in 2009/10.

Among the key points to note in understanding the meaning of the impact values reported in Table 3:

- GDP captures only the value of *final* output, as reflected in the direct expenditures made to produce the good or service in question (in this case knowledge). Rather than adding the gross value of output, only value added (or income) is carried from one stage of the production process to the next in arriving at the net contribution to the economy.
- Compared with the direct and induced impacts, the indirect impact is relatively low. This is because goods and services account for a relatively small part of direct spending (40%) by universities. It also reflects the level of import content of many of the goods purchased in the Atlantic Provinces. The larger impact occurs at the induced stage as incomes earned in direct and indirect activity spin their way through the economy.

[8] The tax revenue impacts do not include corporate taxes.

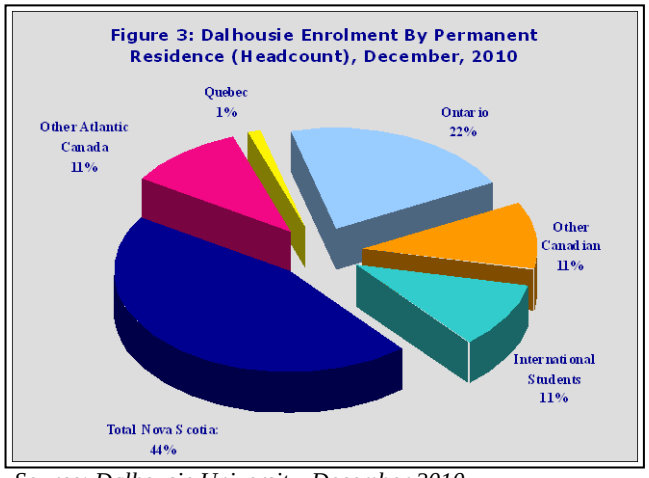
IV
DOMESTIC & INTERNATIONAL STUDENTS

Dalhousie University attracts 56% of enrolment from out-of-province

Dalhousie University attracts nearly 17,000 students from Nova Scotia, the rest of Canada and abroad, and offers post-secondary education in more than 125 undergraduate, graduate and professional degree programmes. In addition to arts and social sciences, science, management and computer science degree programmes, the University offers professional and specialized training in a variety of health professions, medicine, dentistry, architecture and planning, engineering and law. Dalhousie University has attracted increased enrolment in recent years, with overall numbers up by some 61.6% compared with the early 1990s.[9]

In addition, an increasing number of Dalhousie graduates stay in the Region, providing an expanding knowledge economy providing the educated workforce required for growth and diversification.

University research and education activity is considered an economic export of Nova Scotia when students and researchers register from elsewhere in Canada or abroad. Enrolment of out-of-province Canadian students represent 45% of overall total enrolment. This is augmented further by international student enrolment. Total out-of-province enrolment comprises 56% of total Dalhousie University enrolment, representing an export benefit for the province.



Source: Dalhousie University, December 2010

Total student enrolment figures are presented for Dalhousie University in Table 4 below. Undergraduates represent 83% of all students, and most students regardless of their level of study are registered full-time (81%).

[9] Total enrolment at Dalhousie University in 1990-91 was 10,395 and 16,800 in 2010-11(excluding Kings), showing an increase of 61.6 percent over this period. Source: Dalhousie Registrar's Office, 2011.

Table 4:
Dalhousie University (excluding King's)

ENROLMENT BY FACULTY AND PERMANENT RESIDENCE (HEADCOUNTS) As Of December 1, 2010

PERMANENT RESIDENCE	Architecture & Planning	Arts & Social Sciences	Computer Science	Engineering	Health Professions	Combined/ Multi-Faculty	Manage-ment	Science	Dentistry	Law	Medicine	Graduate Level	TOTAL
Metro. Area	60	828	126	512	674	17	242	899	43	87	289	750	4,527
Other Nova Scotia	21	409	55	357	668	10	138	599	53	60	158	460	2,988
Total Nova Scotia:	**81**	**1,237**	**181**	**869**	**1,342**	**27**	**380**	**1,498**	**96**	**147**	**447**	**1,210**	**7,515**
Prince Edward Island	12	42	3	49	89		8	51	10	5	31	74	374
New Brunswick	10	103	15	67	171	3	51	268	46	18	145	228	1,125
Total Maritime:	**103**	**1,382**	**199**	**985**	**1,602**	**30**	**439**	**1,817**	**152**	**170**	**623**	**1,512**	**9,014**
Newfoundland & Labrador	3	21	1	27	30		9	17	27	30	20	103	288
Quebec	2	42	1	15	7		25	41	4	3	12	68	220
Ontario	69	976	13	110	294	21	592	625	24	137	119	613	3,593
Manitoba	3	16	1	3	8		4	15		3	12	43	108
Saskatchewan	6	21		2	8	1	6	16	2	5	12	28	107
Alberta	22	110	6	60	30	2	60	98	9	49	35	115	596
British Columbia	20	143	2	27	27	1	44	97	6	71	46	201	685
NWT, Nunavut & Yukon		6		1	3		1	7	1	3	1	13	36
Canadian living abroad	5	60	4	41	13	1	36	62		4	12	49	287
Canadian - Not Reported											2	1	3
Total Canadian	**233**	**2,777**	**227**	**1,271**	**2,022**	**56**	**1,216**	**2,795**	**225**	**475**	**892**	**2,745**	**14,934**
International Students	**22**	**145**	**70**	**267**	**27**	**4**	**286**	**259**	**27**	**5**	**53**	**592**	**1,757**
GRAND TOTAL:	**255**	**2,923**	**297**	**1,539**	**2,049**	**60**	**1,502**	**3,054**	**252**	**480**	**945**	**3,337**	**16,693**

Source: Dalhousie University, Registrar's Office, December 2010

International student enrolment accounts for 11% of total

International students represent 11% of total Dalhousie University enrolment, however full-time international undergraduates are 16.0% of all full-time undergraduates, and 11.3% in the case of part-time undergraduates (Table 5).[10] This suggests international students are more likely than the average to pursue undergraduate degrees on a full-time basis. The same is true and more pronounced at the graduate level where full-time international graduate students are 37.2% of the total in this category, and only 8.1% of the total in the case of part-time graduates.

Table 5:
Enrolment of international students by status and level of study
Dalhousie University, (2009)

Status and Level of Study	Enrolment
Undergraduate	
Full-time	832
Part-time	54
Total	**886**
Graduate	
Full-time	452
Part-time	25
Total	**537**
Grand Total	**1,423**

Source: Maritime Provinces Higher Education Commission (www.mphec.ca)

Attracting foreign students represents an international export opportunity for the university sector. Dalhousie University offers excellent education and research opportunities in the fields of engineering, business, science, computer science and other professional fields to many students from other countries that may not have access to leading faculty or technology in their field of study in their home country.

International students are also of special interest due to the increased revenues from differential tuition fees they are expected to pay. International students may spend up to double the tuition fees that Canadians are charged for full-time studies at the undergraduate or graduate levels.

Economic impacts of international students are estimated based on the differential fees applied to international students at each university as well as spending by these students on accommodation, food, materials, supplies, and books at the university (not including expenditures outside the university).

International students spent an estimated $25.5 million in tuition, books, residence and meals at Dalhousie in 2009/10 and support employment of about 375 full-time equivalents, $20 million worth of income in the local economy, as well as $6 million in federal and provincial tax revenue.

[10] Table 5 provides a breakdown of enrolment figures for international students using 2009 MPHEC enrolment data

Student off-campus spending adds to economic impact

The following provides a detailed breakdown and methodology for the student off-campus and visitor spending estimates presented in Table 2 that are already captured in the economic impacts figures of Table 3. Students contribute to the economic impact of universities in two ways:

- As students, they participate in the economy through their expenditures on living expenses (lodging, food, transportation, clothing) and entertainment (in addition to their expenditures paid to the university). For students living in on-campus housing, the bulk of these expenditures flow to the university. For students living off-campus, a substantial share flows directly to the local business community.

- As graduates, they participate directly in the economy through the application of the knowledge and abilities they have acquired. From a private perspective, this contribution is reflected in how their lives are enriched, the kinds of jobs they hold and the incomes they earn. From a public or social perspective it is reflected in how educational attainment advances economic growth and development.

It is the former source of impact we are interested in estimating in this section. The latter is taken up in Chapter V.

- Approximately $88 million was spent by students in the local economy in addition to the direct expenditures on tuition, books, on-campus housing, and other university fees. In addition to expenditures made directly to the university, students spend in the local economy through their expenditures in restaurants, grocery stores, other retails shops, movie theatres, etc.
- Off-campus students not living at home account for the bulk of this spending, though both the on-campus and at home students also contribute through spending on transportation, entertainment and food.

Visitor spending adds additional economic impact

People visiting Dalhousie University also contribute to the local economy. They visit for a variety of reasons including attending convocations and conferences, conducting business with the universities, and attending major sporting and arts events. Estimating the scope and magnitude of the relevant spending associated with such visits presents a formidable challenge:

- **Data** – Dalhousie University does not have an easy method to track the number and type of such visits, much less the spending associated with them, in any systematic way.
- **Methodology** – not all spending is incremental – some sources of spending would have occurred anyway in the regional or provincial economy (e.g., out-of-town parents visiting for convocation spend in the university community instead of their home community).

The combined effect of the data and methodological constraints makes any estimate highly conjectural. Nonetheless, some observations are possible:

- **Convocation** – the incremental impact is estimated to fall in the range of $186,000 annually. This is based on three key assumptions.
  1. Only spending by visitors from outside Nova Scotia are considered as incremental to the provincial economy.
  2. Relatives and friends of three-quarters of the graduating class from outside the province would attend convocation. This puts the number of visitor-parties at 1,036 (2,605 graduating, times 53% out-of-province, times 75% with parents attending convocation).
  3. Average local spending (i.e. excluding transportation) by each visitor is nearly $368 ($700 per party visiting friends and relatives, 1.9 people per party).[11]

- **Conferences** – all universities host conferences from time to time. These vary widely in size and number and origin of participants. Wherever possible, university facilities are used for meetings, accommodation and meals. Many meetings are held during the spring and summer months when the university is not in session and facilities are available. From an impact perspective, this means the university accounts already capture the bulk of conference revenues and expenditures. The basis for estimating incremental spending (e.g., the number of participants, their origin and spending patterns) is not compiled.

- **Other events** – the vast majority of people attending university-sponsored sports and arts events would come from the local university community. The data needed to estimate the incremental impact of those visiting from outside the local community are not compiled systematically. Consequently, measuring the impact with any confidence is not possible.

Based on this methodology, it is estimated that visiting scholars and researchers as well as friends and family of students spend $15 million on accommodations, food, and tourism activities in Halifax and surrounding areas.

[11] The number of visitors is estimated by the university, while spending for friends and family is estimated according to Nova Scotia Visitor Exit Survey, and spending for scholars and researchers is based on a two-month average length of stay and monthly spending estimates for food and accommodation.

V
VALUING DALHOUSIE'S EDUCATION IMPACTS

Perspective of the economy – growth

Post-secondary education plays a major role in the achievement of high levels of economic growth and development, and to the realization of the broader quality of life and economic wellbeing benefits associated with it. Recognizing this, Canada's federal and provincial governments invest billions of dollars annually to support post-secondary institutions in Canada. That Canada perennially finds itself at or near the top of the United Nations Human Development Index would be attributable at least in part to this support.[12]

Despite its obvious connection, the relative contribution of higher education to economic growth and development defies easy quantification. The primary focus of research in the field is on the contribution of education to productivity growth. The weight of evidence points to significant impact on total factor productivity.[13] Among the conclusions flowing from a review of the literature focusing mainly on OECD countries:[14]

- the growth of human capital (educational attainment) in G7 countries typically accounts for as much as 20% of the growth in total output.
- differences in educational attainment account for most of the differences in output (GDP per capita) variation across OECD members.
- investment in OECD countries is positively correlated with the extent of secondary schooling in the labour force.
- results point to a positive and significant impact of human capital accumulation to output per capita growth; one additional year of education raises output per capita by 6%.
- the level of education plays a role in technological catch-up; productivity growth is more rapid where countries have a higher level of average schooling.
- the balance of recent evidence points to productivity effects of education at least as large as those identified by labour economists (as reflected in income differences due to educational attainment).

A practical and accessible illustration of the significance of higher levels of knowledge lies in the educational requirements in growth areas of the economy. Simply put, most jobs created today in Canada require a post-secondary degree or diploma. Few jobs in the new economy can be filled with just a high school diploma and jobs requiring less than a high school diploma are rapidly disappearing.

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12 United Nations, *Human Development Report, 2005*. Relying on such criteria as real income, life expectancy and educational attainment, Canada was ranked fifth in the 2005 Report, ahead of Sweden, Switzerland, the United States, Japan and the United Kingdom.

13 Total factor productivity refers to the change in output resulting from a change in how labour and capital are combined in the productive process rather than from an increase in the quantity of either factor. An increase in output from such an adjustment, say, in the quality of labour, may be thought of as "working smarter".

14 An excellent review of the literature on the subject may be found in, Temple, J., 2001. *Growth effects of education and social capital in the OECD countries*, OECD Economic Studies.

Additional economic impacts are also realized within an economy the greater its ability to attract and retain businesses to the local area. Businesses actively seek and locate in areas with high educational attainment of the working age population. Areas with higher educational attainment, as well as enhanced research opportunities, have a greater probability of attracting and retaining businesses in their local economy.

Table 6 provides a comparison of the educational attainment of the total population 15 years and older in Halifax with that in the rest of the province and the rest of Canada. Almost one quarter (24%) of the working age population in Halifax have completed a university degree or certificate at least at the bachelor's level, significantly higher than the proportion in the working age population in the province as a whole (16%) or Canada-wide (18%).

Table 6:
Educational Attainment Comparison

Educational Attainment	HRM	Nova Scotia	Canada
Total population 15 years and over	309,105	756,595	25,664,220
No certificate, diploma or degree	**19.5%**	**26.8%**	**23.8%**
High school certificate or equivalent	23.5%	22.8%	25.5%
Apprenticeship or trades certificate or diploma	9.9%	11.9%	10.9%
College, CEGEP or other non-university certificate or diploma	18.6%	17.9%	17.3%
University certificate or diploma below the bachelor level	4.5%	4.1%	4.4%
University certificate, diploma or degree	**24.0%**	**16.4%**	**18.1%**

Source: Statistics Canada, Census 2006 data.

Dalhousie is a significant contributor to the higher than national average proportion of the working age population in Halifax and in Nova Scotia with educational attainment at least at the bachelor's or university certificate level. Dalhousie supplies thousands of highly qualified personnel (HQPs) each year in professions related to medicine, business, law, engineering, dentistry, oceanography, bioengineering, and other health sciences that provide the critical underpinnings for economic growth, diversification and innovation.

Over 75 percent of Dalhousie graduates earn degrees in the professional disciplines, science or computer science

A distinguishing characteristic of Dalhousie is that it is the only university in the province that offers degrees in medicine, law, pharmacy, dentistry, allied health professions, engineering, architecture, and oceanography. The "*Report on the University System in Nova Scotia*"[15], prepared by Dr. Tim O'Neill also recognized Dalhousie as being the largest university with the most comprehensive array of graduate and professional programs, not only in Nova Scotia, but in the Atlantic region.

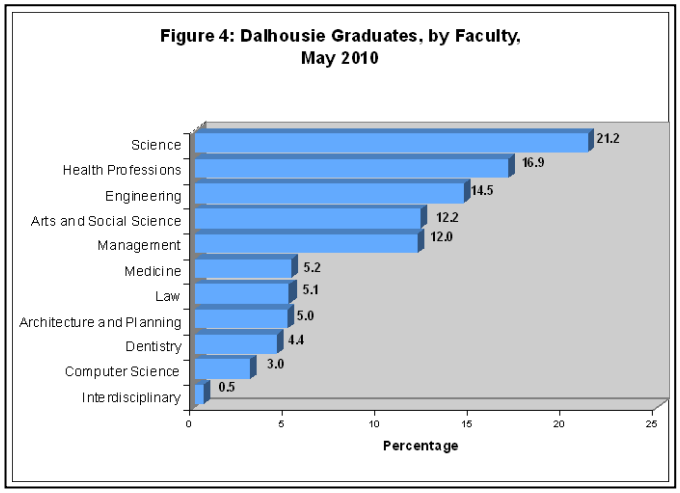
The resulting impact of this is that the university is uniquely positioned to contribute to the innovative capacity of the province of Nova Scotia. As highlighted in the report entitled, "*Invest More, Innovate More, Trade More, Learn More: The Way Ahead for Nova Scotia*", by Donald Savoie, a better-educated, skilled, and experienced labour force, together with a dynamic private sector, is key to improving a region's productivity.[16]

[15] O'Neill, T. "*Report on the University System in Nova Scotia*", prepared for Premier Darrell Dexter, Province of Nova Scotia, September 2010. P. 138.

[16] Savoie, Donald, "*Invest More, Innovate More, Trade More, Learn More: The Way Ahead for Nova Scotia*", July, 2010.

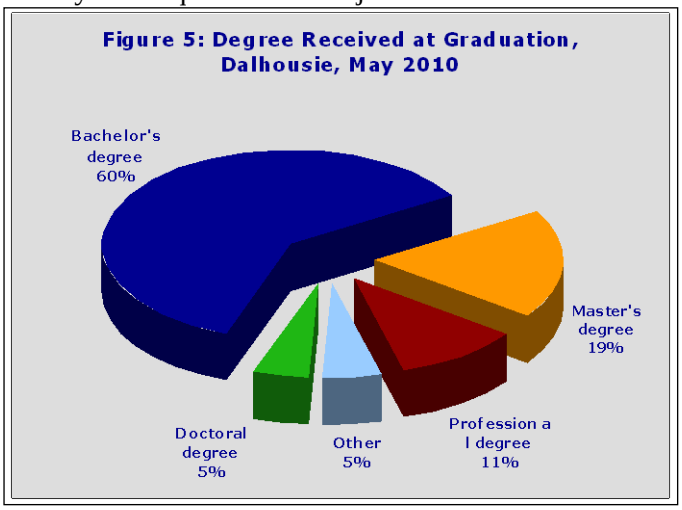
The report also highlights the key linkages between a highly qualified labour force with expertise in research-related disciplines and improved economic productivity of the economy. Policy makers want to attract talented, well-educated immigrants who can help Nova Scotia thrive in the face of two major challenges: an aging population and a growing shortage of skilled workers. Thousands of highly qualified persons (HQPs) graduate from Dalhousie annually and become employed in the Nova Scotia economy, many of whom originated from other parts of Canada or abroad. The recent Dalhousie Career Services Centre report *Destination Survey for the graduating class of 2010* provides information regarding the nature of the degree earned and employment of Dalhousie's graduating students as well as, their retention in the Nova Scotia economy.[17]

Over 75 percent of 2010 graduates earned degrees in the sciences and professional disciplines, including law, medicine, engineering, dentistry, architecture and planning, allied health sciences, science and computer science. The highest percentage of students graduated with degrees in science (21%) followed by the Faculty of Health Professions (17%), and engineering (14.5%).[18]



Not only are Dalhousie graduates earning degrees in professional programs and the sciences, the majority are also finding jobs in their area of specialization. The majority of graduates (79.8%) suggested a degree related to their field of study was required for their job.

While the majority (60%) of Dalhousie graduates received a bachelor's degree, a large proportion (35%) received either a professional or graduate degree. A total of 5% received another degree.



Given that incoming students at Dalhousie hold one of the highest overall grade point averages (GPA) in the country, it is not surprising that its students are graduating with high cumulative grade point averages. A majority (52.2%) of graduates hold a cumulative grade point average of 3.5 or higher with 30.1% holding a cumulative grade point average of 3.75 or higher.

17 This survey was conducted on-line with students who graduated in May 2010 from Dalhousie University and was administered by Dalhousie's Office of Institutional Analysis and Research (OIAR). A total of 946 students responded to this survey (34% response rate).

18 2010 Destination Survey results, Dalhousie's Office of Institutional Analysis and Research (OIAR), 2010.

Many of Dalhousie's programs require an internship component to complete their degree. In this manner, foreign and out-of-province students are already exposed to the workplace, (e.g., hospitals, law offices, engineering firms, research centres, etc.), and the businesses and institutions have an opportunity to observe them as they work. There is an incentive for many out-of-province students and researchers to remain in the province and a sizeable proportion of remain in Nova Scotia – in particular in the health professions (roughly 53 percent of the 2010 Dalhousie graduates work in Nova Scotia). In addition, close to a third of Dalhousie graduates (30.7%) characterized their job area as being in the health field while another 13.4% characterized their job area in the science, engineering, and mathematics fields.

A large proportion of Dalhousie graduates are retained in the Nova Scotia economy

The Maritime Provinces Higher Education Commission (MPHEC) undertakes surveys with Maritime university graduates and collects information regarding their employment outcomes, earnings, province of residence and perceptions of their post-secondary education. The MPHEC study *"Two Years On: A Survey of Class of 2007 Maritime University Graduates"* provides a summary of the results for Maritime university graduates in 2007 surveyed two years after graduating in 2009. Table 7 provides a summary of the distribution of place of residence for Dalhousie graduates in 2007 based on the MPHEC survey two years later (surveyed in 2009). This data provides a rich source of information for university graduates in 2007, allowing for an analysis of the number of Dalhousie graduates retained in the provincial economy two years after graduation.

Table 7:
Distribution of place of residence for Dalhousie graduates (Class of 2007) by origin, (MPHEC survey two years following graduation, 2009)

		Province of residence in 2009		
Dalhousie University Graduates Class of 2007	**Residence 12 months prior to enrolling in degree completed in 2007**	**Nova Scotia**	**Prince Edward Island & New Brunswick**	**Outside Maritimes**
First Degree Holders:				
	Nova Scotia	71%	3%	26%
	Prince Edward Island & New Brunswick	35%	39%	26%
	Outside Maritimes	19%	4%	78%
All Other Graduates:				
	Nova Scotia	63%	1%	35%
	Prince Edward Island & New Brunswick	38%	45%	17%
	Outside Maritimes	21%	2%	77%

Source: MPHEC Survey of Class of 2007 Maritime University Graduates in 2009
Note: Margin of error for n=150 is ±8% (95% confidence interval); for n= 200, ±7%; for n=25, ±20%

The distribution of place of residence for first degree holders is similar to that of other graduates. In percentage terms, a larger percentage of Dalhousie graduates originating from outside Nova Scotia are retained in the province than the percentage of Dalhousie graduates originating in Nova Scotia. While over a quarter (26 percent) of 2007 Dalhousie first degree graduates that originated in Nova Scotia (living in Nova Scotia prior to entering Dalhousie) moved outside the Maritimes in 2009, an even larger percentage originating from outside of Nova Scotia have been retained in

the Nova Scotia economy. Roughly 35% of Dalhousie first degree graduates originating from the rest of Maritimes and 19 % originating from outside the Maritimes were retained in the Nova Scotia economy two years after graduating in 2007. Similarly, 38% of Dalhousie graduate degree holders originating from the rest of Maritimes and 21 % originating from outside the Maritimes were retained in the Nova Scotia economy two years after graduating in 2007.

This represents roughly 1,680 Dalhousie graduates from the class of 2007 (total of 3,864 graduates) that have remained in the provincial economy two years after they have graduated. Of the 1,678 graduates retained in the local economy, roughly 570 originated from outside of Nova Scotia prior to their enrolment at Dalhousie.

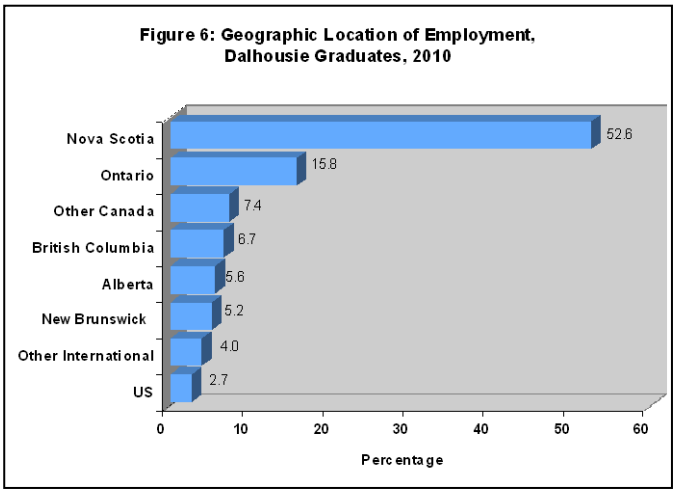
A large proportion of Dalhousie graduates are employed in the Nova Scotia economy

The MPHEC "*Two Years On: A Survey of Class of 2007 Maritime University Graduates*" survey data indicates that roughly 80.6 percent of graduates in 2007 included in the survey were engaged in the labour force in 2009, and of those attached to the labour force, roughly 86 percent were employed. Based on the estimated 1,680 Dalhousie graduates in 2007 retained in Nova Scotia economy in 2009, the MPHEC survey results indicate that roughly 1,162 of the Dalhousie graduates in 2007 are employed in the Nova Scotia economy two years after graduating (2009). Applying the MPHEC results to the number of Dalhousie graduates in 2010 (5,487 graduates), an estimated 1,650 Dalhousie graduates will remain and be employed in the Nova Scotia economy.

These results are similar to the results of the 2010 Dalhousie *Destination Survey*, which estimates that of the 5,487 Dalhousie students graduating in 2010, a total of 2,464 are currently working and of those working, roughly 1,306 are working in Nova Scotia. These results are likely to underestimate the total number working in Nova Scotia given that the 2010 *Destination Survey* was taken immediately following students' graduation.

The 2010 Dalhousie *Destination Survey* results provide an overview of the geographic location of employment of the recent Dalhousie graduates currently working. The majority of 2010 Dalhousie graduates that are currently working report that they are working in the Nova Scotia economy. Of those working, slightly over half (52.6%) of 2010 graduates reported working in Nova Scotia while 15.8% reported working in Ontario. Other destinations for Dalhousie graduates include British Columbia (6.7%) Alberta (5.6%), New Brunswick (5.2%), rest of Canada (7.4%). A small proportion of graduates are working in the US (2.7%) and other international (4%).

Figure 6: Geographic Location of Employment, Dalhousie Graduates, 2010



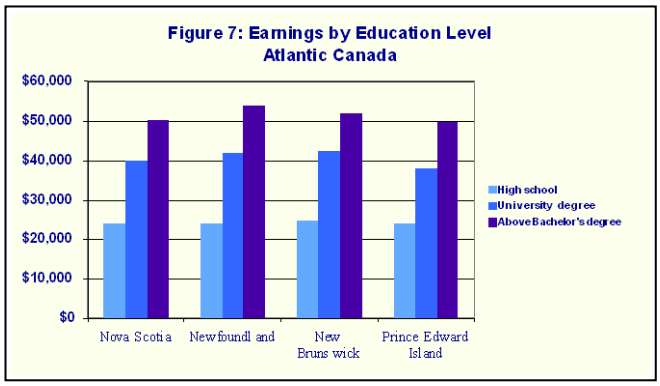
Earnings Differential of Higher Educated Workforce

Higher educational attainment provides substantial value to the individuals themselves, to the economies where highly educated individuals work, and to society overall. A recent special report by Human Resources and Skills Development Canada (HRSDC), (2008) entitled "*What Difference Does Learning Make to Financial Security?*"[19] identifies the key benefits of higher education levels as being higher earnings and lower unemployment risks, both of which contribute to individuals´ and household financial security.

These earnings differentials can make the investment in a university education worthwhile from a financial perspective at the individual level. However, these earnings differentials also translate into significantly higher fiscal tax impacts for both provincial and federal levels of government. This paper estimates the present value of the lifetime earnings differential as a measure of economic gain at the individual level. We also estimate the relevant incremental tax impacts associated with the present value of the lifetime earnings differential for Dalhousie graduates retained in the local economy as a partial measure of the economic value of associated with the university's educational programming from society's perspective.

The overall average earnings typically rise with years of education, with the earnings curve for those with high school or less, flattening relatively quickly.

The Statistics Canada 2006 Census data indicate that earnings rise with education level in all provinces and territories across Canada.[20] This data also shows that the Canada-wide earnings differential for full-time workers with bachelor's degrees is 57% more than those who have not completed university and individuals with a first university degree earn an average of *60-70% more per year* than individuals with a high school diploma.



This is certainly true in Atlantic Canada. With a graduate degree beyond the bachelor's level, the earnings premium level rises to *over 100%.* Holders of graduate degrees earn about 25% more than those with a bachelor's degree.

Table 8 provides a comparative breakdown of the earnings differential in Nova Scotia for full-time employees by educational attainment between those with a bachelor's level, below a bachelor's level, and above a bachelor's level.

The average annual earnings differential in the Nova Scotia labour force between those with a bachelor's degree and those without is $17,221 per person (in 2005 dollars) with an earnings differential between those above a bachelor's level and those at a bachelor's $16,659 per year. However, the average annual earnings differential between those above a bachelor's level and those below a bachelor's level is roughly $33,880 per year (in 2005 dollars). Table 8 shows

[19] For full report, see http://www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=54
[20] Source: Statistics Canada, Census, Catalogue no. 97F0017XCB2001002.

Table 8: Average earnings of population 15 years and over by highest level of schooling, Nova Scotia (2006 Census)		
Salaries	**Earnings ($2005)**	**#People**
(1) Below bachelor's level	$26,215	404,800
(2) bachelor's	$43,436	67,975
(3) Above bachelor's level	$60,095	35,525
Earnings Differentials		
	($ 2005)	**2005 Earnings Differentials Expressed in $2010**
(2) - (1)	$17,221	$18,783
(3) - (2)	$16,659	$18,170
(3) - (1)	$33,880	$36,953

Source: Statistics Canada, Census 2006 http://www40.statcan.gc.ca/l01/cst01/labor50a-eng.htm

Given the high proportion of Dalhousie graduates that remain in the provincial economy combined with the fact that the university produces all of the Nova Scotia-trained doctors, dentists, engineers, lawyers, biomedical engineers, oceanographers, and the majority of physical therapists, pharmacists, among many thousands of other professionals, we can safely conclude that a large part of the earnings differential is attributable to Dalhousie educational programs.

Economic Returns to Higher Education – Individual Perspective

Investment in higher education not only benefits society more generally by improving public health, safety, the environment, and such imponderables as political and community participation, it also benefits the individual. Individuals make the investment to attend university for various reasons including love of learning, self-improvement, securing interesting work, and also in the expectation of earning a higher income. The economic returns to individuals measured as the increase in lifetime earnings has been well documented in the literature. The special report done by Human Resources Development and Skills Development Canada (HRSDC) entitled, "*What Difference Does Learning Make to Financial Security?"*[21] (2008) uses Canadian Census data on earnings across all provinces and found that the knowledge-based economy is driving a greater-than-ever demand for skills and higher education levels. Using recent Canadian data on education attainment and earnings levels, this report found that in all provinces and territories, higher education yields higher earnings.

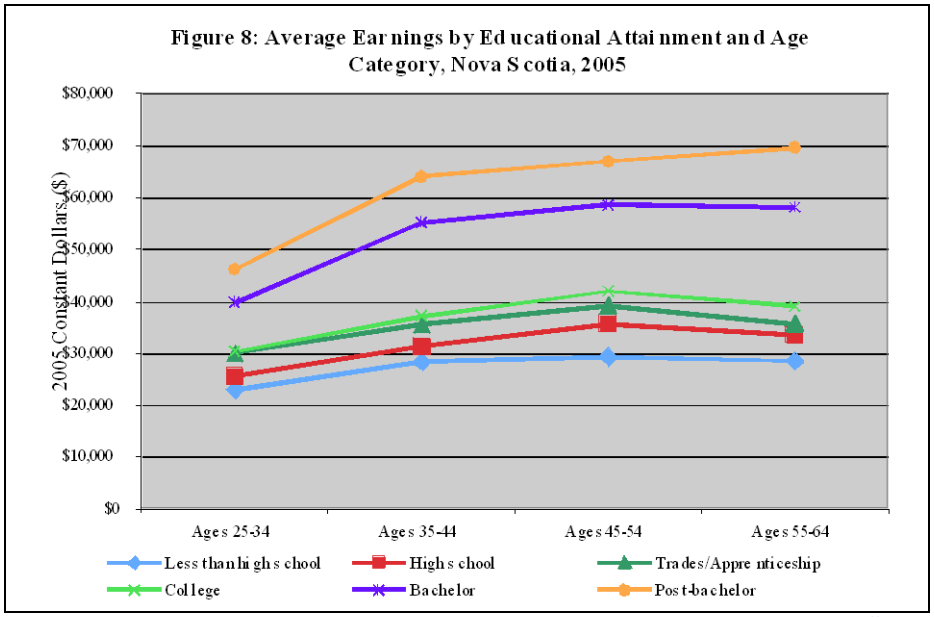
Measures of the earning differential due to education indicate this earnings differential is growing over time. Census Canada 2000 data shows that those who completed their education with a high school diploma earned on average $4,300 more than those without a high school diploma and achieving education beyond high school offered an even greater earnings benefit. [22]

An examination of the average earnings differential over an individual's lifetime shows that while earnings typically increase during an individual's peak earning period (aged 35 to 54), the average earnings differential due to differences in education attainment holds over the lifetime earnings stream.

[21] Human Resources and Skills Development Canada, "What Difference Does Learning Make to Financial Security?", January 2008. See http://www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=54.

[22] Source: Statistics Canada, Census, Catalogue no 97F0019XCB2001002.

Census 2006 data for Nova Scotia illustrates a substantial average earnings differential between individuals holding a bachelor or post-bachelor degree and those with a high school diploma or with less than high school level of education, and more importantly, this earnings differential increases over one's working lifetime. Also, it can be seen that the average earnings differential for those with a high school diploma or less flattens out early in the lifetime earnings stream, contributing to an increased earnings differential later in life.[23]



Source: Human Resources Development and Skills Development Canada (HRSDC) entitled, *"What Difference Does Learning Make to Financial Security?"*[24] (2008)

Based on the earnings statistics for the Nova Scotia labour force, the cumulative lifetime earnings differentials for those holding university degrees translates into substantial returns to investing in education for individuals. An estimation of the lifetime earnings associated with a Dalhousie degree at the bachelor's level or higher is readily quantifiable using current published earnings statistics for the Nova Scotia labour force as well as current statistics on Dalhousie graduates and their retention in the provincial economy.

We estimate the value of a university degree for a Dalhousie graduate over their working lifetime based on the value of the annual earnings differential due to education over a 40 year career using a discount rate to obtain the standard present value calculation over an income stream. This calculation includes two major adjustments that must be made in order to derive an economically sound average net present value for a university degree. An adjustment for the explicit (out-of-pocket) costs of the degree must be made in addition to the opportunity costs of the time spent earning the degree. To value lost earnings while earning a degree, we use the average fulltime earnings for people under 24 without a university degree in Nova Scotia using census data. The earnings differential in 2005 is adjusted to 2010 dollars to determine the equivalent annual return over investment (e.g., costs). In addition, the annual incremental earnings and the costs are discounted to adjust for the fact that costs and benefits occur annually, using a discount rate of both 3 and 5 percent for comparison purposes.

[23] Income data from the 2001 and 2006 Canadian Census surveys relate to the calendar year prior to the census year, i.e., 2000 and 2005 respectively. For additional information, please refer to the 2006 Census Dictionary, Catalogue no. 92-566-XWE.

[24] Human Resources and Skills Development Canada, "What Difference Does Learning Make to Financial Security?", January 2008. See http://www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=54.

The net present value of the cumulative earnings differential associated with a bachelor's degree (over a degree less than a bachelor's) is estimated to be $277 thousand dollars (using a 3 percent discount factor). Similarly, the net returns associated with a degree higher than the bachelor's level is estimated to be roughly $667 thousand dollars.[25]

The private returns to education for Dalhousie graduates not working in the Nova Scotia market would be based on the earnings differentials specific to the labour market in which they are working. Given that the growth in labour demand in the past 16 years has been largely for degree holders, it is difficult to dispute the value of the university degree, both to the individual and to the labour market.

The returns to higher education are much greater than the net present value of incremental lifetime earnings to the individual.

A growing body of literature examining the benefits of investment in education to both the individual and to society at large have identified the linkages to increased economic well being as a result of increased education. Wolfe, B and Haveman, R. in "*Accounting for the Social and Non-market benefits of Education*", provide a summary of this literature and argue that these effects are substantially larger than the market-based returns to education and must be considered in order to correctly evaluate the optimum level of investment in education.[26] We take this topic up in the following discussion on the economic benefits resulting from higher education from society's perspective.

Economic Returns to Higher Education – Society's Perspective

Lifetime net earnings differentials due to university education also translate into significant marginal tax impacts. In fact, this becomes a non-trivial benefit when estimating the marginal tax impact associated with the present value of the cumulative lifetime earnings differential for Dalhousie university graduates (based on the proportion of Dalhousie graduates that receive either a professional or graduate degree) that are retained in the Nova Scotia economy. Similar to the point of reference associated with the static economic impacts associated with the university-related direct expenditures in the economy, the comparison point of reference for the Dalhousie university graduates retained in the local economy is to consider the economy without the university's existence. Given the nature of the educational programs and professional and graduate degrees offered at the university, without Dalhousie University the province would not have the opportunity to educate and retain these graduates, and would have to attract them from other regions of the country or abroad with the similar degrees (and associated research opportunities) as those offered by Dalhousie.

The incremental tax revenue is based on the earnings differentials using the most recent Census data available (2006 Census providing earnings data in 2005) provided in Table 8 above, converted to 2010 dollars. Based on the Census 2006 data shown in Table 8 above, the average earnings in 2005 in Nova Scotia for those holding a bachelor's degree is $43,436 and $60,095 for those holding a degree higher than a bachelor's degree.

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25 The net present value of the cumulative life-time earnings differential associated with a Dalhousie graduate for a degree higher than the bachelor's value is $527 thousand using a discount factor of 5 percent and $593 thousand using a discount factor of 3 percent.

26 Wolfe, B and Haveman, R. *Accounting for the Social and Non-market benefits of Education*, in "The Contribution of Human and Social Capital to Sustained Economic Well-being", ed. John Helliwell with the assistance of Aneta Bonikowska, Human Resources Development Canada, PQ, 2001 provide a summary of the literature examining the non-market benefits of investment in education.

The average earnings by education level are converted to 2010 values, and the 2010 Nova Scotia only marginal tax rates on personal income are examined to determine the appropriate marginal tax rate for this analysis.[27] From the province of Nova Scotia's perspective, it is the marginal Nova Scotia tax rates (and not the combined Federal and Nova Scotia tax rates) that are relevant to determine the incremental tax revenues to the province based on the earnings differentials for Dalhousie University graduates retained and working in the province. The 2010 Nova Scotia marginal tax rate of .167 on personal income is used to estimate the incremental tax benefits associated with the earnings differential for Dalhousie graduates employed in the Nova Scotia economy. It should be noted however, that the marginal tax rates on personal income do not include the indirect tax impacts on goods and services consumed, property taxes, or corporate taxes resulting from business start-ups, and therefore, the estimated marginal tax impacts in this analysis underestimate the total marginal tax impacts associated with the earnings differentials of Dalhousie graduates.

The marginal tax rate is applied to the earnings differential in 2005 (expressed in 2010 dollars) for those holding a bachelor's degree and those holding higher than a bachelor's degree, to determine the present value of the marginal tax value for the province of Nova Scotia as a result of the annual earnings differential due to education over a 40 lifetime earnings stream. The annual incremental tax benefits are discounted using a discount rate of 3 percent.[28]

The present value of the tax impact for the province of Nova Scotia associated with the incremental earnings for those with a bachelor's degree is estimated to be $72.4 thousand dollars over their lifetime earnings stream and $142.4 thousand for those holding a degree higher than the bachelor's level (over a 40-year earnings stream using a 3 percent discount factor).[29]

We also estimate the marginal tax impacts for the provincial economy based on the Dalhousie graduates retained and employed in the province. We begin by estimating the marginal tax impacts based on the Dalhousie graduates from the most recent year (2010) retained and employed in the province. We then estimate the marginal tax impacts based on the estimated total Dalhousie alumni working in the provincial economy in 2010.

To estimate the marginal tax impacts for the provincial economy based on the number of graduates from Dalhousie in 2010, we utilize the proportion of students graduating with a bachelor's and a higher than bachelor's degree from Dalhousie in that year, as well as the estimated proportion of 2010 Dalhousie graduates that are employed in Nova Scotia. Applying the proportion of graduates employed in Nova Scotia based the results of the MPHEC study "*Two Years On: A Survey of Class of 2007 Maritime University Graduates"* (outlined above), to the 2010 Dalhousie graduates (5,487)[30], results in an estimated 1,650 Dalhousie alumni from the class of 2010 working in the Nova Scotia economy.[31]

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27 The marginal tax rate is based on the 2010 http://www.taxtips.ca/taxrates/atlantic.htm

28 Annual incremental tax benefits discounted using discount rate of both 3 and 5 percent for comparison purposes.

29 The present value of the cumulative tax impact associated with a bachelor's degree is $53.7 thousand using a discount factor of 5 percent and $72.4 thousand using a discount factor of 3 percent. The present value of the cumulative tax impact associated with a degree higher than a bachelor's degree is $105.7 thousand using a discount factor of 5 percent and $142.4 thousand using a discount factor of 3 percent.

30 A total of 5,487 students graduated from Dalhousie in 2010 including both Spring and fall convocation, excluding Kings graduates. Source: Dalhousie Office of Institutional Analysis and Research, December 10, 2010.

31 Based on the MPHEC study "*Two Years On: A Survey of Class of 2007 Maritime University Graduates", MPHEC, January, 2011.*

Based only on the number of Dalhousie graduates in 2010 that are retained and employed in the Nova Scotia economy, the total cumulative marginal tax benefit for the province of Nova Scotia is estimated to be $160 million on the incremental earnings of these graduates over a 40-year working lifetime.[32] This translates into an average annual tax impact of $4 million per year attributable only to the incremental lifetime earnings for students graduating from Dalhousie in 2010 and employed in the provincial economy. This is considered to be a conservative estimate as this analysis assumes the earnings differentials by education level attained as well as the marginal tax rate remain constant over the course of the working lifetime (40 years).

However, the marginal tax benefits for the Nova Scotia economy not only result from the Dalhousie graduates working in the provincial economy based on the number of students graduating in the current year. Rather, it results from all Dalhousie graduates from previous years currently working in the economy. For example, in 2010, the incremental tax impacts accruing to the economy includes the average tax impact of $4 million per year accruing in 2010 in addition to the incremental tax impacts accruing to the economy resulting from the Dalhousie graduates from previous years retained in the provincial economy and currently part of the Nova Scotia labour force. An analysis of Dalhousie alumni working in the Nova Scotia economy, the degrees they earned through Dalhousie and their earnings provides an estimate of the annual marginal tax impact associated with Dalhousie graduates for the provincial economy.

The total number of Dalhousie alumni living in Nova Scotia in 2010 is estimated to be 47,087.[33] This is considered to be a conservative estimate of the total Dalhousie alumni living in Nova Scotia and is based on an estimated 102,767 living Dalhousie alumni in total. The distribution of alumni living in Nova Scotia by age category is provided in Table 9. As can be seen in Table 9, an estimated 4,218 Dalhousie University alumni living in Nova Scotia are aged 65 and older, with an additional 660 records with no stated age provided. As a conservative estimate, we assume that half of those with no stated age are 65 or older, leaving an estimated total of 42,540 working aged alumni living in Nova Scotia.

Table 9:
Estimated Number of Dalhousie University Alumni Living in Nova Scotia[34]
By Age Category 2010

Age Group	Dalhousie Alumni in Nova Scotia
18 to 24	2,681
25 to 34	12,417
35 to 49	14,849
50 to 64	12,262
65+	4,218
No age stated	660
Total	**47,087**

Source: Dalhousie Alumni Relations, Dalhousie University, 2010

32 The total present value of the cumulative tax impacts associated with a bachelor's degree is estimated to be $78 million (based on an estimated 1,073 students retained and working in the Nova Scotia economy receiving a bachelor's degree) and $82 million (based on an estimated 578 Dalhousie students receiving higher than a bachelor's degree in 2010 and retained and working in Nova Scotia). Analysis based on a discount factor of 3 percent.

33 The estimated number of Dalhousie alumni living in Nova Scotia was obtained from Dalhousie Alumni Affairs. This estimate is based on an estimated 112,322 alumni from Dalhousie in total; Of the total Dalhousie Alumni that are alive (102,767), roughly 80,767 have active addresses. Of those with active addresses, roughly 90% are Canadian addresses (73,071) and 37,007 are Nova Scotia addresses. Applying these proportions to the total estimated living Dalhousie alumni yields an estimated 47,087 Dalhousie alumni living in Nova Scotia.

34 Dalhousie Alumni data are as of June 2010.

An estimate of the total annual marginal tax impacts for the province attributable to all Dalhousie University graduates is obtained based on the total number of alumni currently employed in Nova Scotia (as of December, 2010). Information on the number of alumni employed in the provincial economy was not available based on the current Dalhousie University alumni data.[35] To provide a broad (and conservative) estimate of the magnitude of the marginal tax impact, this study applies the results from the MPHEC study "*Two Years On: A Survey of Class of 2007 Maritime University Graduates*", resulting in an estimated 29,487 Dalhousie alumni currently employed in the Nova Scotia economy.[36] An analysis of Dalhousie alumni data shows that roughly 33.1 percent of alumni living in Nova Scotia received a degree higher than a bachelor's degree. The percentage distribution of alumni living in Nova Scotia that received a bachelor's degree and those that received a degree higher than a bachelor's degree is applied to the estimated alumni working in Nova Scotia to provide an estimate of the total cumulative marginal tax impact for is estimated.

This results in a total cumulative marginal tax benefit for the province of Nova Scotia of $2.86 billion over a 40-year working lifetime based on the estimated total number of Dalhousie alumni that are retained and employed in the Nova Scotia economy in 2010 as well as the nature of the degrees they hold.[37] This translates into an average annual tax impact of $71.4 million per year for the Province of Nova Scotia attributable to the incremental earnings (earnings differential) of Dalhousie alumni currently retained and employed in the provincial economy. As mentioned above, this is considered to be a conservative estimate as this analysis assumes the earnings differential as well as the marginal tax rate remains constant over the course of the working lifetime (40 years).

Socio-demographic Returns to Higher Education

In addition to the marginal tax benefits to the provincial economy attributable to the earnings of Dalhousie University alumni working in the province, the province benefits from substantial socio-demographic impacts due the increase in the level of education in population. The majority of students enrolled at Dalhousie originate from outside the province (Table 4 above) and based on the results of the MPHEC survey of 2007 Dalhousie graduates, 35% of first degree holders and 38% of all other graduates originating in other Maritime provinces were residing in Nova Scotia in 2009. A similar result was true of Dalhousie graduates in 2007 originating from outside the Maritime provinces, with roughly 20% living in Nova Scotia 2 years after graduating from Dalhousie.

To the extent Dalhousie students originating from outside the province are retained and working in the provincial economy after graduation, this represents not only a net annual increase in population overall, but a substantial socio-demographic impact associated with increase in university educated young adults entering the labourforce, an increase in the average education

35 Information on the number of alumni employed in the provincial economy was not available at the time of this report based on the current Dalhousie Alumni Affairs data.

36 The MPHEC study "*Two Years On: A Survey of Class of 2007 Maritime University Graduates*" survey data indicates that 80.6 percent of 2007 graduates are engaged in the labour force in 2009, and of those attached to the labour force, roughly 86 percent are employed.

37 The total present value of the cumulative tax impacts associated with Dalhousie alumni holding a bachelor's degree is estimated to be $1.29 billion (based on an estimated 19,219 Dalhousie retained and working in the Nova Scotia economy holding a Dalhousie bachelor's degree) and $1.34 billion associated with an estimated 10,349 Dalhousie alumni holding a degree higher than a bachelor's degree and working in Nova Scotia. Analysis based on a discount factor of 3 percent.

level of the province and a contribution to the overall economic wellbeing, resulting in sizeable economic impacts for the province.

A number of published studies have examined the socio-demographic benefits to an economy that are directly linked to increased education. Barbara Wolfe and Robert Haveman in their paper entitled *Accounting for the Social and Non-market benefits of Education* published by Human Resources Development Canada in "The Contribution of Human and Social Capital to Sustained Economic Well-being"[38] provide a summary of the literature examining the socioeconomic contribution of increased education and investment in human capital to economic growth and well-being. The socioeconomic impacts of investments in education outlined by Wolfe and Haveman include the following:

- a positive link between an individual's level of education and the education received by their children;
- a positive relationship between an individual's level of education and their own health status (resulting in lower health care costs);
- a positive association between an individual's and the health status of their family members (resulting in lower health care costs);
- a positive relationship between an individual's level of education and their socioeconomic outcomes, as well as the socioeconomic outcome of their offspring. These socioeconomic impacts include:
    - reduced risk of unemployment,
    - reduced risk of periods of lower income,
    - reduced crime,
    - increased financial security, and
    - increased savings for retirement.

Wolfe and Haveman provide an extensive summary of research documenting results related to identifying and measuring the intergenerational impacts resulting from investments in education. This body of research provides substantial evidence that educational attainment in one generation has positive effects on the educational attainments of their offspring (including health, education, and crime related activities) in the next generation. The socioeconomic impacts related to investment in higher education include the direct relationship of parental educational attainment (human capital investment) to the educational attainment of their children, and the indirect socioeconomic impacts through improving the social capital of the surroundings and environment in which children grow up.

In addition, a more educated workforce is more likely to possess a greater capacity to develop technologies and innovative processes (resulting in increased productivity) and to have greater capacity to receive and apply new technologies (increased receptor capacity). In addition, businesses are more likely to locate in areas with a higher educated workforce and a larger proportion of HQPs.

While the socioeconomic and intergenerational impacts of investment in education are generally omitted when assessing the economic impact of education, the results of the literature indicate that these effects are large, and perhaps larger the market-based impacts of education (marginal tax benefits and private returns to education), and therefore should be considered to correctly evaluate the optimum level of investment in education.

[38] Wolfe, B. and Haveman, R., "Accounting for the Social and Non-market benefits of Education", in The Contribution of Human and Social Capital to Sustained Economic Well-being, Ed. John Helliwell with the assistance of Aneta Bonikowska, Human Resources Development Canada, PQ, 2001.

These socio-economic impacts translate into real and sizable economic impacts, and become particularly important when considered at a time when provincial governments are faced with aging populations, labour force shortages, rising health care costs, and in most cases, smaller budgets. It is clear that any assessment of the optimal level of investment in education requires a comprehensive assessment of all of the returns to education, both market-based returns (earnings differentials, marginal tax impacts, GDP, employment) as well as the socioeconomic impacts (associated with increased financial security, reduced risk of unemployment and crime, as well as reduced health care costs).

Linkages Between Higher Education and Financial Security

The 2008 report released by Human Resources and Skills Development Canada (HRSDC) (entitled *What Difference Does Learning Make to Financial Security)* examines the linkages between education in increased financial security.[39] This study uses Canadian census data to explore the extent to which financial security is influenced by education.[40] The results of this study show that the benefits of higher education include not only higher earnings, but also lower unemployment risks, and lower risk of experiencing low income, all of which contribute to individuals´ and families´ financial security.

The results of this report show that higher education in Canada is associated with higher earnings as well as:

- greater savings and assets;
- higher growth in earnings;
- higher income during retirement.

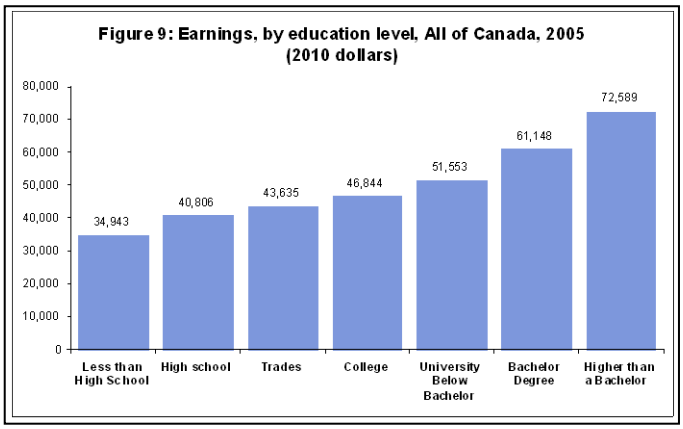
The results of the 2008 HRSDC report also showed that higher education yields higher earnings in and also reduces the risk of experiencing:

- periods of low income; and
- unemployment.

These results were true for all provinces and territories.

For Canada as a whole, those who completed their education with a bachelor's degree earned on average $20,340 more than those with a high school diploma.

Achieving education beyond high school yields an even greater earnings benefit.



Source: Statistics Canada, Census, Catalogue #: 97F0019XCB2001002.

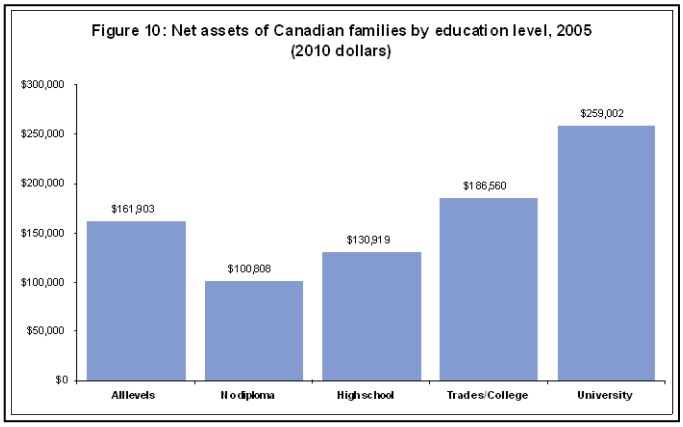
39 Human Resources and Skills Development Canada (HRSDC), Special Report Series: *What Difference Does Learning Make to Financial Security)*, January 2008, www.hrsdc.gc.ca.

40 Financial security is defined as a situation in which income is sufficient to meet the basic needs of a family or individual.

Higher Education Leads to Greater Savings and Assets

There is a positive relationship between the level of education attained and the value of accumulated savings and assets.[41] A comparison of median net assets (net assets correspond to assets net of debts) by education level is shown in Figure 10. All results are based on the year 2005 and measured in 2010 dollars.

In 2005, the median value of net assets among those who completed their education with a high school diploma was $131,000, roughly $30,000 more than for those without a diploma.[42]



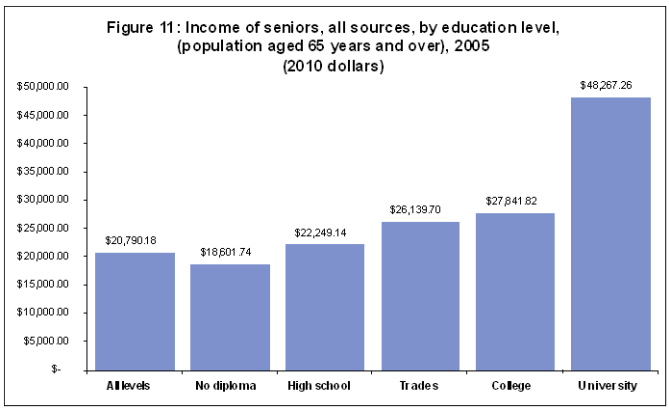
Source: Statistics Canada, Survey of Financial Securities 2005.

However, Canadians with post-secondary education accumulated even higher levels of net assets, with median net assets among university graduates was close to $128,000 higher than the median net assets for those holding a high school degree.

Higher Education Contributes to Higher Income During Retirement

There is a positive relationship between the level of education attained and the income of seniors (population aged 65 years and older).[43] A comparison of median income of seniors by education level based on 2006 census data (expressed in 2010 dollars) is shown in Figure 11.

Analysis of the median income for seniors by education level shows markedly higher income levels for seniors with university degrees. The median income for seniors holding a university degree ($48,000) is more than double the median income ($21,000) for all seniors (all levels of education).
For university-educated seniors the median income was roughly $20,000 higher than for those graduating from colleges or trades.



Source: HRSDC calculations using Statistics Canada, Census 2006

41 Results highlighted in the 2008 Human Resources and Skills Development Canada (HRSDC), Special Report Series: *What Difference Does Learning Make to Financial Security)*, January 2008, www.hrsdc.gc.ca.

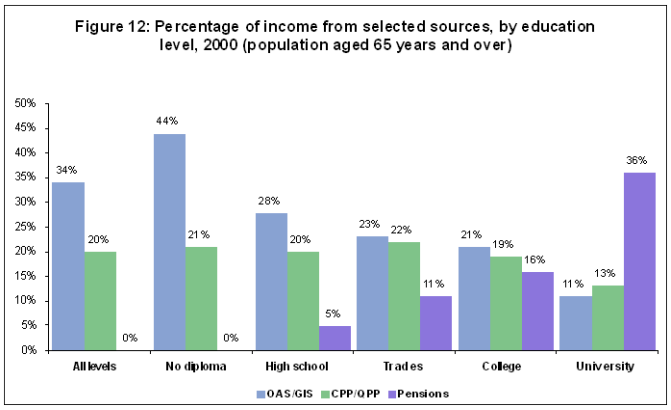
42 Comparisons are made using the median value of assets in 2005 valued in 2010 dollars.

43 Human Resources and Skills Development Canada (HRSDC), Special Report Series: *What Difference Does Learning Make to Financial Security)*, January 2008, www.hrsdc.gc.ca.

Seniors With Higher Levels of Education Rely Less on Old Age Security (OAS)

Analysis of the median of annual gross income for seniors (aged 65 and older) by education level reveals another critical result with respect to the source of income for seniors. In addition to examining the size of income for seniors by education level, comparisons are also made of the source of income for seniors. The sources of income include Old Age Security, Canada Pension Plan, and Private pension plans. It should be noted that private pensions includes employer-sponsored pensions and private pension plans but not investment income or savings.

This analysis shows that seniors with lower levels of education rely more on Old Age Security (OAS/GIS) and Canada Pension Plan (CPP) benefits whereas seniors with higher levels of education rely more on private pensions as a source of income.



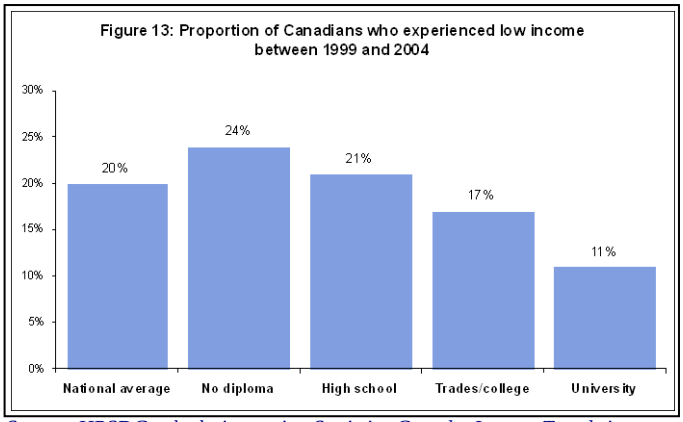
Source: HRSDC calculations using Statistics Canada, Census 2001.

Seniors with no diploma relied solely on OAG and CPP. Roughly 44% of all OAG/GIS benefit payments are made to seniors that do not hold a diploma and almost 30 percent to those with a high school degree.

Higher Education Reduces the Risk of Experiencing Low Income

There is an inverse relationship between the level of education attained and the incidence of experiencing low income.[44] A comparison of the proportion of Canadians who experienced at least one year of low income between 1999 and 2004 by education level is shown in Figure 13.[45]

This analysis shows that a lower proportion of Canadians with a university degree or post-secondary diploma were likely to experience low income.



Source: HRSDC calculations using Statistics Canada, Income Trends in Canada, catalogue no 13F0022XIE.

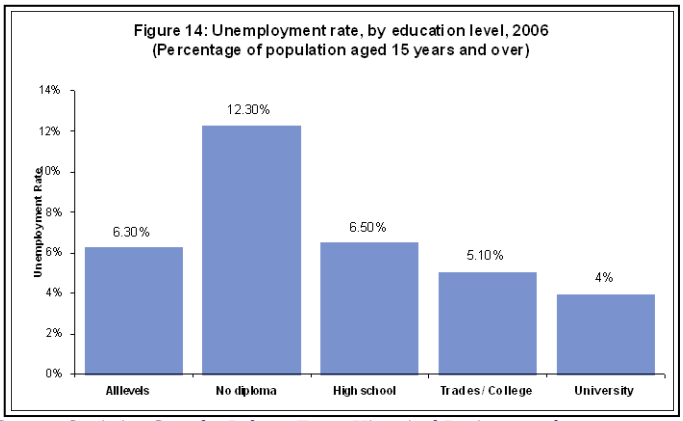
[44] Results highlighted in the Human Resources and Skills Development Canada (HRSDC), Special Report Series: *What Difference Does Learning Make to Financial Security)*, January 2008, www.hrsdc.gc.ca.

[45] The definition of low income is based on after-tax Low Income Cut-Offs (LICOs). Includes anyone who experienced at least one year of low income.

The proportion of Canadians with a university degree (11%) that experienced at least one year of low income during this period is less than half the percentage of those with no diploma (24%) and roughly half of those with high school diploma (21%) over this time period. This same result held true when examining the proportion of Canadians that experienced prolonged low income (3 years or more). Roughly 11% of Canadians without a diploma and 9% of high school graduates experienced prolonged low income while only 3% of university graduates experienced prolonged low income over this same period.

Higher Education Reduces Risk of Unemployment

Higher education not only reduces the risks of experiencing low-income, it also reduces the probability of unemployment. A comparison of the unemployment rate of Canadians by education level is shown in Figure 14 using the most recent Census Canada data.



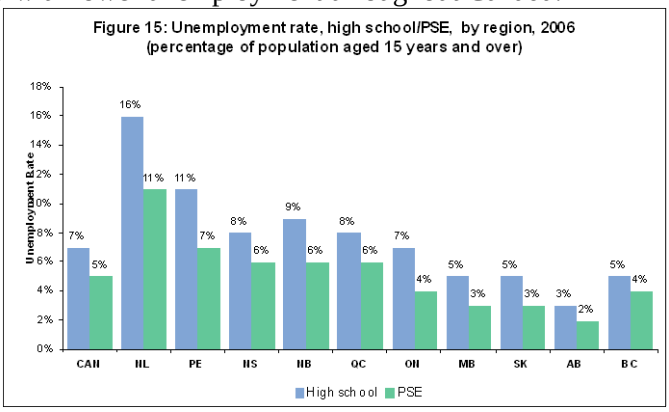
Source: Statistics Canada, Labour Force Historical Review, catalogue no. 71F0004X

Analysis of the unemployment rate by education level shows that Canadians holding a university degree had one-third the risk of experiencing unemployment (4%) than those with no diploma (12.3%) in 2006. For Canadians with post-secondary education, the unemployment rate was comparatively low (5.1% for trades and college graduates and 4.0% for university graduates).

Higher Education Reduces Risk of Unemployment in all Provinces

In examining the unemployment rate for Canadians by education level and across provinces, it becomes readily apparent that holding a post-secondary diploma (PSE) as compared to obtaining a high school diploma only is associated with lower unemployment throughout Canada.

The difference in the unemployment rates between high school and post secondary education ranged from 1 percent (Alberta and BC) to 5 percent (Newfoundland and Labrador) percentage points. In Nova Scotia the rate of unemployment in 2006 was above the national average, with the unemployment rate at 8 percent for high school graduates and 6 percent for those with PSE.

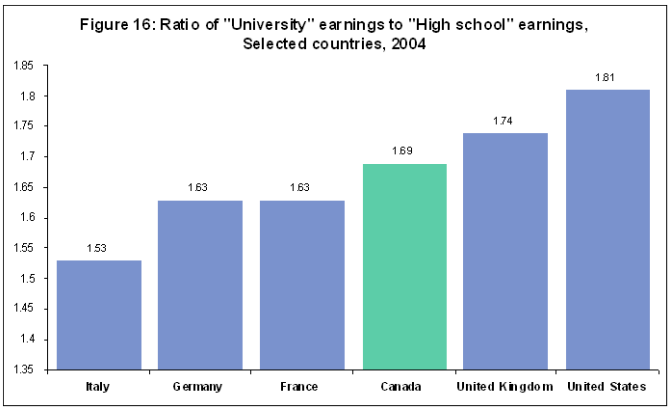


Source: HRSDC calculations using Statistics Canada, Labour Force Historical Review, catalogue no 71F0004X.

Canadian University Earnings Differentials Comparable to Other Industrialized Countries

In comparing the earnings differential for those holding university degrees to the earnings of those for whom high school is the highest education level attained across countries, we see that Canada fares well among industrialized countries.

The ratio of earnings for those with a university degree to the earnings for those with a high school diploma is comparable to most industrialized countries. Canadian university graduates earned about 1.7 times more than high school graduates (relatively close to university graduates in the United Kingdom), whereas university graduates in the United States earn roughly 1.8 times more than high school graduates.[46]



Source: Organisation of Economic and Development Cooperation, Education at a Glance 2006, table A9.1a.

In summary, higher levels of education contribute to financial security through higher earnings, higher earnings growth, lower risk of unemployment and periods of low earned income, greater accumulation of net worth, and higher income in retirement. These results have important implications for provincial governments faced with declining populations, declining workforce, increasing health care costs and decreased revenues.

University Education Reduces Health Care Costs

A large body of research indicates that Canadians in lower socio-economic status have higher needs for health services, and this result holds true for Canadians of all age groups.[47] [48] [49]

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46 Notes: 1) The data is for the year 2003 for Canada and 2002 for Italy. 2) The ratio of earnings is obtained by dividing the average earnings of the higher education level by the average earnings of the lower education level.

47 Canadian Institute for Health Information, *Exploring Urban Environments and Inequalities in Health—CPHI Data Briefs Cover Canada's 33 Census Metropolitan Areas* (Ottawa, Ont.: CIHI, 2010), accessed from <http://www.cihi.ca/cihiweb/dispPage.jsp?cw_page=cphi_cma_canada_2010_e>. See also Canadian Institute for Health Information, *Injury Hospitalizations and Socio-Economic Status* (Ottawa, Ont.: CIHI, 2010).

48 Canadian Institute for Health Information, *Health Indicators 2010* (Ottawa, Ont.: CIHI, 2010). See also Canadian Institute for Health Information, *Reducing Gaps in Health: A Focus on Socio-Economic Status in Urban Canada* (Ottawa, Ont.: CIHI, 2008).

49 M. Lemstra et al., "High Health Care Utilization and Costs Associated With Lower Socio-Economic Status: Results From a Linked Dataset," *Canadian Journal of Public Health* 100, 3 (2009): pp. 180–183.

This is also the conclusion of recent reports by the Chief Public Health Officer[50] and the Senate Subcommittee on Population Health[51], as well as an international report by the World Health Organization whose results point to disparities in health outcomes (using multiple measures of health) associated with socio-economic status.[52]

The 2008 Canadian Institute for Health Information (CIHI) report *Reducing Gaps in Health: A Focus on Socio-Economic Status in Urban Canada* showed that hospitalization rates for multiple health indicators were consistently higher for people in lower socio-economic groups than for the middle and high groups in each of the Canadian Census Metropolitan Areas (CMAs) examined. This analysis is an extension of previous work by the Canadian Population Health Initiative (CPHI) examining the relationship between health and socio-economic status.

One of the main drivers for socio-economic status is education, and university education in particular. Statistics Canada conducts the National Population Health Survey, which is a longitudinal study on the determinants of health and the basis for the agency's Statistical Report on the Health of Canadians. The report cites that "socio-economic status in general, and education specifically, is very often positively associated with health status and health behaviours". [53] A university education tends to increase: financial security, job security and satisfaction, literacy and numeracy skills. These are considered to be important to the population for accessing health products and services, making healthy decisions, and avoiding physical and mental health illness associated with challenging socio-economic conditions.

Health Care Savings Associated with a University-Educated Population

The 2008 Canadian Institute for Health Information (CIHI) report *Reducing Gaps in Health: A Focus on Socio-Economic Status in Urban Canada* showed that hospitalization rates for multiple health indicators were consistently higher for people in lower socio-economic groups than for the middle and high groups in each of the Canadian Census Metropolitan Areas (CMAs) examined. This analysis is an extension of previous work by the Canadian Population Health Initiative (CPHI) examining the relationship between health and socio-economic status.

New Canadian research (2010) by the CIHI, *Hospitalization Disparities by Socio-Economic Status for Males and Females*,[54] examines differences in hospitalization rates by socio-economic status for 15 CMAs using 2006 Census Canada data. The 2010 CIHI analysis expands on the previous work by examining magnitude of the disparities in hospitalization rates across socio-economic groups as well as the estimated costs associated with the higher hospitalization rates in lower socio-economic groups in the CMAs examined. This study estimates the cost of hospitalization associated with differences in hospitalization rates for acute care hospitalizations, also known as *Ambulatory Care Sensitive Conditions (ACSC)*, where the main diagnosis was for

50 Public Health Agency of Canada, *The Chief Public Health Officer's Report on the State of Public Health in Canada: Addressing Health Inequalities* (Ottawa, Ont.: Minister of Health, 2008).

51 The Senate Subcommittee on Population Health of the Standing Senate Committee on Social Affairs, Science and Technology, *A Healthy, Productive Canada: A Determinant of Health Approach* (Ottawa, Ont.: Senate of Canada, 2009).

52 World Health Organization, *Closing the Gap in a Generation: Health Equity Through Action on the Social Determinants of Health* (Geneva, Switzerland: WHO, 2008), accessed from <http://whqlibdoc.who.int/publications/2008/9789241563703_eng.pdf>.

53 Millar W, Stephens T. Social status and health risks in Canadian adults: 1985 and 1991. *Health Reports* 1992; 5: 143–156 (Statistics Canada Cat. No. 82-003-XPB).

54 Canadian Institute for Health Information (CIHI), "Hospitalization Disparities by Socio-Economic Status for Males and Females", October 2010

one of seven conditions for which hospitalization rates were consistently higher for people in lower socio-economic groups than for the middle and high groups in each of the Canadian Census Metropolitan Areas (CMAs) examined in the 2008 CIHI report *Reducing Gaps in Health: A Focus on Socio-Economic Status in Urban Canada* (diabetes, asthma, chronic obstructive pulmonary disease, heart failure and pulmonary edema, hypertension, epilepsy, and angina). ACSC hospitalization rates used in this study are calculated only for patients younger than age 75, roughly corresponding to the life expectancy in the developed world.[55]

Education is considered a key factor in determining socioeconomic status and health outcomes. The 2010 CIHI report defines socio-economic status to include both material factors (education, income, employment) and social factors (marital status, living arrangement) combined in the socioeconomic index.[56] Residents were ranked according to the socioeconomic index and assigned to one of five quintiles (20% groupings), each representing a population with a different socio-economic level. The highest socio-economic status (Group 1) represents residents that represent the top 20% of the total population in each census metropolitan area based on ranking according to the socioeconomic index. Similarly, those in the lowest socio-economic status fall into the bottom 20% of the population (Group 5), and represent those with lower material and social factors as described above.

This study uses a measure of 'excess' hospitalization rates to compare differences in hospitalization rates across socioeconomic groups. The term 'excess' refers to hospitalization rates over and above those observed in the group with the lowest hospitalization rate. Based on recent Canadian research, the hospitalization rate in the highest socio-economic status group is significantly lower than the rates for other groups for both physical and mental health conditions[57] and is therefore used as the reference group (base rate) to which every other group is compared. The total 'excess hospitalization rate' for a health condition is calculated by summing the excess rates across all socio-economic status groups and converted to a rate per 100,000 by dividing by 5 (number of groups in the total population) to yield an average rate comparable to the overall hospitalization rate.

To determine the costs to society associated with excess hospitalizations, costs of hospitalization are examined by type of illness.[58] These costs were determined in 2004 dollars and are expressed in 2010 dollars based.

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55 Deaths prior to age 75 are considered premature and potentially avoidable. See Canadian Institute for Health Information, *National Consensus Conference on Population Health Indicators, Final Report* (Ottawa, Ont.: 1999).

56 This study uses the Deprivation Index defined by the Institut national de santé publique du Québec to determine the socio-economic status in each of the census metropolitan areas examined, based on 2006 census data.

57 Canadian Institute for Health Information, *Reducing Gaps in Health: A Focus on Socio-Economic Status in Urban Canada* (Ottawa, Ont.: CIHI, 2008).

58 The costs of acute care hospitalizations are based on the cost estimates provided in the 2008 CIHI report *The Cost of Acute Care Hospital Stays by Medical Condition in Canada, 2004–2005*. Hospitalization costs should be interpreted as crude estimates only due to differences in definitions of ACSCs and mental illness between the Discharge Abstract Database (mental illness) and the report *The Cost of Acute Care Hospital Stays by Medical Condition in Canada, 2004–2005*.

Table 10: Costs of Hospitalization by Type of Illness, Canada, $2010				
	Males	Proportion due to Condition	Females	Proportion due to Condition
ACSC Conditions				
Angina	$6,565	16%	$5,911	10%
Asthma	$2,627	18%	$3,155	19%
Chronic Obstructive Pulmonary Disease	$9,362	24%	$8,710	31%
Diabetes	$11,776	13%	$11,197	14%
Grand Mal Status and Other Epileptic Convulsions	$8,884	9%	$8,547	9%
Heart Failure and Pulmonary Edema	$11,647	18%	$10,275	14%
Hypertension	$13,126	2%	$12,272	2%
ACSC Weighted Average Cost	***$8,472***		***$8,004***	
Mental Illness Average Cost	**$9,886**	**100%**	**$10,014**	**100%**

1. Hospitalization costs are based on the cost estimates provided in the 2008 CIHI report *The Cost of Acute Care Hospital Stays by Medical Condition in Canada, 2004–2005, converted to $2010.*
Note: ACSC average cost is weighted by proportion of all ACSC hospitalizations due to specified underlying condition. Cost of chronic obstructive pulmonary disease is the estimated cost of chronic lower respiratory diseases, except asthma.

Hospitalization rates are examined the Halifax Census Metropolitan area (CMA) for acute care, also known as *Ambulatory Care Sensitive Conditions (ACSC)*, and mental illness hospitalizations.[59] The lowest four socioeconomic quintiles in Halifax were found to have more hospitalization days (more frequent and longer stays) relative to the highest socioeconomic group (Table 11) for both types of hospitalization. It is worth noting that this result was also found to be true on average for the other 14 CMAs across Canada examined in the CIHI study. By combining the amount by which hospitalizations in each quintile exceeded the hospitalization rates for the socioeconomic ranking with the lowest hospitalization rates (the highest socioeconomic quintile group) a total excess hospitalization rate per 100,000 of population in Halifax is calculated. The total excess hospitalizations per year in Halifax (per 100,000 people) for both ACSC (952) and mental illness (958) hospitalizations are shown in Table 11.

Table 11: Hospitalizations per 100,000 of population in Halifax Census Metropolitan Area (CMA), by socio-economic status (SES) ranking		
Socio-economic Ranking:	**ACSC hospitalizations**	**Mental illness**
1—Highest	410	410
2	457	459
3—Middle	426	426
4	765	769
5—Lowest	944	944
Total hospitalizations	3,002	3008
Total Excess*	**952**	**958**

Source: CIHI, 2010.
**Excess hospitalizations are the sum of the differences between the highest ranking group (1) and each of the other groups (2-5).*

59 See Canadian Institute for Health Information, *Technical Note: Ambulatory Care Sensitive Conditions (ACSC)* (2010), Appendix A for more details on the data sources accessed from <http://secure.cihi.ca/cihiweb/dispPage.jsp?cw_page=tech_acsc_2010_e>.

The study assumes average hospitalization cost by type of illness are constant across socio-economic status groups and the total cost associated with excess hospitalization rates are estimated based on the weighted average cost of hospitalizations.

The total cost of estimated excess hospitalization rates as well as the proportion of the total cost that is excess for the Halifax CMA are estimated to assess the magnitude of the disparities across socioeconomic groups. The excess costs of acute care and mental illness hospitalizations in Halifax are shown in Table 12.[60]

Table 12:
Socio-economic status related excess hospitalization costs in Halifax ($M per 100,000 population) 2010 dollars

Measure	ACSC hospitalizations	Mental illness	Total
Average ($/hospitalization)	**$8,238**	**$9,950**	
Total ($M/100,000 pop)	$24.73	$29.93	$54.66
Excess ($M/100,000 pop)	$7.84	$9.53	$17.37

Source: CIHI, 2010. Costs shown in the study were converted here to 2010 dollars using the Nova Scotia consumer price index.

Based on this analysis, approximately 32% of the overall hospitalization rate in Halifax is estimated to be excess. Applying these results to the total population of Halifax (372,860), we see that if residents in all socio-economic groups in Halifax had the same hospitalization rates as those in the highest socio-economic status group, an estimated $35.5 million could be saved per year for mental illness and $29.24 million saved for ACSCs. This potentially translates into savings to the system of $64.8 million in decreased hospitalization rates.

Applying these figures to the province's 942,506 residents provides an estimated total cost of excess hospitalization rates. Based on these results, if residents in all socio-economic groups in the province had the same hospitalization rates as those in the highest socio-economic status group, an estimated $90 million could be saved per year for mental illness and $74 million saved for ACSCs, translating into savings of $164 million in total decreased hospitalization rates for the province. It should be noted that the application of these costs to the province as a whole would likely underestimate excess hospitalization rates and costs due to the relatively higher unemployment rate and lower average income and education levels for the province as a whole as compared to Halifax, causing increased variability in socioeconomic strata. However, this analysis provides a broad estimate and suggests there is roughly $164 million in excess annual health care costs related to socioeconomic conditions in Nova Scotia.

Dalhousie University, through its contribution to improved higher education, may provide savings of $33 million annually in Nova Scotia health care costs.

Dalhousie University graduates can be found in multiple socioeconomic quintiles, but their education has advanced them from lower socioeconomic categories than they would have otherwise occupied. Advancement in socioeconomic status has reduced their propensity to incur health care costs.

[60] The cost of total and excess hospitalization costs per 100,000 persons in 2010 dollars are the result of multiplying hospitalization rates by the weighted average costs per hospitalization.

Dalhousie alumni living in Nova Scotia number roughly 48,000, contributing to a reduction in excess hospitalizations. The relevant question becomes: what would the excess health care costs be without Dalhousie's contribution to the improved socio-economic status of residents? The Province would slip further in terms of hospitalizations in excess of those in the highest socioeconomic status. As a broad estimate, an increase of just 20% would yield $33 million in additional health care costs each year. Alternatively, Dalhousie University through its contribution to improved socio-economic status and health of residents may provide annual savings of $33 million in Nova Scotia health care costs.

This analysis builds on previous national and international studies indicating people with lower socio-economic status have poorer health outcomes (higher hospitalization rates,[61] higher mortality rates[62], or shorter life expectancy[63], compared to those with higher socio-economic status.[64] The disparities in health outcomes are associated with disparities in education level and socio-economic status and are ultimately reflected in the costs to the health care system.

Public and Private Expenditure on Education

The 2007 Pan-Canadian Education Indicators Program (PCEIP) report[65] provides information on public and private expenditures on secondary education across jurisdictions in Canada. In aggregate, all levels of government spent $75.7 billion on all levels of education in Canada in fiscal year 2005-06 representing 16.1% of total public expenditure.[66] A comparison of Canadian jurisdictions over the period between 1997-98 and 2002-03 illustrates that total government expenditure on education increased across western provinces and in the territories, as well as in Prince Edward Island and Quebec, with the increases ranging from 8% in Prince Edward Island to 22% in Alberta. However, expenditure decreased by 2% in Nova Scotia and Ontario, and by 16% in Newfoundland and Labrador.[67] This can also be examined by comparing expenditures on secondary education as a percentage of GDP.

61 M. Lemstra et al., "High Health Care Utilization and Costs Associated With Lower Socio-Economic Status: Results From a Linked Dataset," *Canadian Journal of Public Health* 100, 3 (2009): pp. 180–183.

62 Michèle Dupont et al., *Inégalités sociales et mortalité des femmes et des hommes atteints de cancer au Québec, 1994-1998* (Québec, Que.: Institut national de santé publique du Québec, 2004), pp. 1–11.

63 C. N. McIntosh et al., "Income Disparities in Health-Adjusted Life Expectancy for Canadian Adults, 1991 to 2001," *Health Reports* 20, 4 (2009): pp. 55–64.

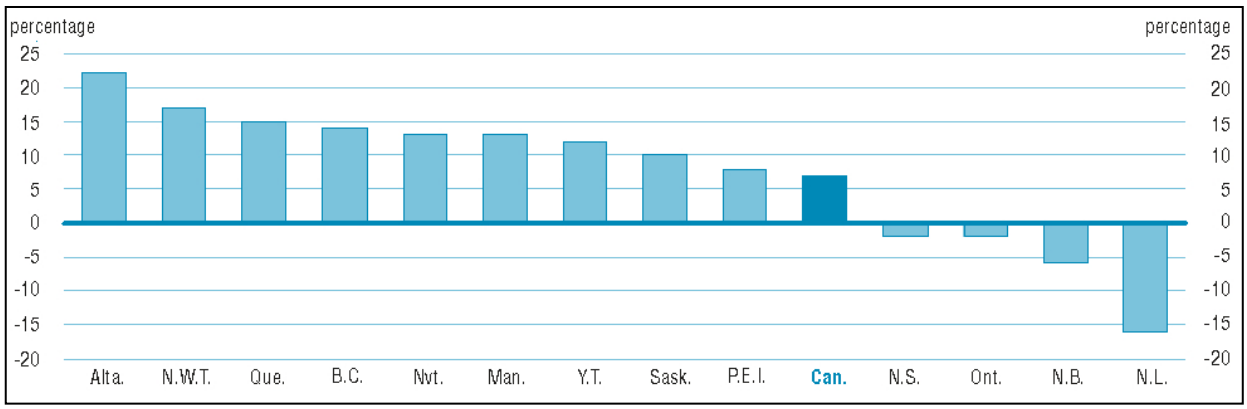
64 World Health Organization, *Closing the Gap in a Generation: Health Equity Through Action on the Social Determinants of Health* (Geneva, Switzerland: WHO, 2008), accessed from <http://whqlibdoc.who.int/publications/2008/9789241563703_eng.pdf>.

65 Pan-Canadian Education Indicators Program, *Education Indicators in Canada: Report of the Pan-Canadian Education Indicators Program*, Council of Ministers of Education, Canada, Statistics Canada, 2007.

66 Pan-Canadian Education Indicators Program, *Education Indicators in Canada: Report of the Pan-Canadian Education Indicators Program*, Council of Ministers of Education, Canada, Statistics Canada, 2007, Table B.2.1.

67 Expenditure increases were higher at the postsecondary level for most jurisdictions. However, Nova Scotia, Newfoundland and Labrador, and New Brunswick experienced a decrease in postsecondary expenditure

Figure 17:
Percentage change in public expenditures on education between 1997-98 to 2002-03, constant 2001 dollars, Canada and the jurisdictions



VI
DALHOUSIE PLAYS A KEY ROLE IN THE KNOWLEDGE ECONOMY

Increasingly, economies are relying on higher and deeper levels of education to meet the challenges of remaining competitive in a global environment rapidly redefining its requirements in response to shifting demands and supply capabilities.[68] Canada and the world are experiencing great social and economic change. This revolution, driven by new knowledge, technology and innovation, has led governments and industries to recognize the need for investing in knowledge to steer their organizations through future developments.

While Dalhousie makes an immediate and substantial contribution to the economy through its educative function, the university also plays a major role in performing the basic and applied research fundamental to innovation, growth and diversification. Dalhousie University and its affiliated teaching hospitals constitute the largest, comprehensive, research-intensive, academic organization in Atlantic Canada with eleven faculties and eighty academic departments. Dalhousie has internationally recognized programs in research and graduate and professional studies.

Dalhousie University occupies a pivotal role in the knowledge economy for the province of Nova Scotia and Canada as a whole. Through research and teaching, the university acts as an enterprise supplying knowledge and HQPs. In carrying out this function, it also contributes to the demand side of the economy. Dalhousie has built substantial research capacity for the local and provincial economy through an extensive and diverse variety of research programs and activities that reinforce a cooperative, collaborative and interdisciplinary approach to research and education. These processes have also fostered new partnerships with other regional, national, and international universities, the affiliated teaching hospitals (IWK and QEII), governments and industry.

Dalhousie is consistently named among Canada's top research universities in Canada. Dalhousie holds 47 CRCs, closely following the University of Manitoba (50) and Queens University (54). The number of CRCs allocated to a university is proportional to the amount of research grant funding that university has received in the three years prior to the year of the allocation. Grant funding must originate from the three federal granting agencies (NSERC, CIHR, and SSHRC). Roughly two thirds (66%) of Chairs are allocated to member institutions of the G13, a group of the top research-intensive universities in Canada.

The following table provides a breakdown of the distribution of CRCs among the top research universities in Canada.

[68] The 2003 Statistics Canada Labour Force Survey reports that between 1990 and 2003, 1.4 million jobs were created for university degree holders, while 1.2 million jobs were lost for those with less than a high school diploma.

Table 13: Canada Research Chair (CRC) Allocations, Canada's Top Research Institutions	
Institution	**# of Chair Holders**
University of Toronto	249
University of British Columbia	168
McGill University	153
Université of Montréal	105
University of Alberta	110
Université Laval	88
University of Calgary	73
University of Ottawa	71
McMaster University	68
University of Western Ontario	65
University of Waterloo	58
Queen's University	54
University of Manitoba	50
Dalhousie University	47

Source: CRC Program, http://www.chairs-chaires.gc.ca/program-programme/2008_allocations_attributions.pdf.

Dalhousie holds 23 Tier 1 Chairs and 24 Tier 2 Chairs. Tier I Chairs are reserved for outstanding researchers acknowledged by their peers as world leaders in their fields. Tier 1 Chairs are tenable for seven years and renewable indefinitely. Tier 2 Chairs are reserved for exceptional emerging researchers, acknowledged by their peers as having the potential to lead in their field. These Chairs are tenable for five years. Table 14 provides a breakdown of the distribution of Dalhousie's CRCs by funding source.

Table 14: Distribution of Dalhousie's Canada Research Chairs				
	Funding Source			
Canada Research Chairs	CIHR	NSERC	SSHRC	Total
Chairs				
Tier 1 Chairs	9	11	3	23
Tier 2 Chairs	10	11	3	24
TOTAL	**19**	**22**	**6**	**47**

Source: CRC Program, http://www.chairs-chaires.gc.ca/program-programme/2008_allocations_attributions.pdf.

A list of Dalhousie's research centres and technical facilities is provided in the Appendix.

VII
VALUING DALHOUSIE'S RESEARCH IMPACTS

Although providing higher education may be an educational institution's most important "service," it is generally agreed that research carried out within a university also provides a critical contribution to society.[69] Dalhousie University occupies the central role in conducting research and development (R&D) in the province and in the Atlantic. Using the most recent year for which complete data are available[70], total research income from all sources accruing to Nova Scotia's university system in 2008-09 reached $170 million. Of the total overall funds for sponsored research in Nova Scotia, Dalhousie's share of both total government support (66 per cent) and non-government income (81 per cent) is 75 per cent (Table 13). In 2009-10, the university's level of sponsored research increased to over $130 million.

Table 15:
Sponsored research, by university ($000), Nova Scotia, 2008-09

	Total Research Funding
Acadia	5,055
AST	445
Cape Breton	4,689
Dalhousie	125,633
Mount Saint Vincent	3,388
NS Agricultural College	10,407
NSCAD	553
St. Mary's	8,507
St. FX	10,554
U King's	56
U Sainte-Anne	303
Total	169,590

Source: Canadian Association of University Business Officers (CAUBO), Income by Fund Table, Report 3.1, 2009-10.
1. Includes total consolidated and non-consolidated research funds from government and non-government sources.

One way of measuring the research intensity is to examine the sponsored research funds per faculty member. This comparison is made for federal research funds in the O'Neill report for Nova Scotia universities, and found that even when correcting for relative size, Dalhousie receives more funding per faculty member than any other institution in Nova Scotia.[71]

The number of times a particular piece of research is cited by other academics is another measure commonly used to indicate research quality, knowledge creation and dissemination. In the case of Dalhousie University, the evidence on knowledge production and dissemination is overwhelming. According to the Science Citations Index (SCI) of the ISI Web of Knowledge, Dalhousie ranks extremely high in science and engineering publication citations, with a total of 36 Dalhousie

69 Recognized in the report prepared by Tim O'Neill, "Report on the University System in Nova Scotia", prepared for Province of Nova Scotia, September 2010. P. 137.

70 Canadian Association of University Business Officers (CAUBO), Income by Fund Table, Report 3.1, 2009-10.

71 Tim O'Neill, "Report on the University System in Nova Scotia", prepared for Province of Nova Scotia, September 2010. P. 140. Report uses Sponsored research data from Canadian Association of University Business Officers and faculty data from Statistics Canada.

faculty members having more than 2,000 citations. To achieve more than 2,000 citations of publications in journals covered by SCI indicates that the scholar is extremely influential in their area of specialty in the world. Further to this, a total of 7 Dalhousie researchers have more than 10,000 citations, something that is extremely rare and far exceeding the number of citations by many of Nobel Prize winners in Physics, as a matter of reference.

It is also common to examine the average number of citations per faculty member. In a recent ranking of universities produced by US News and World Report, Dalhousie tied with the University of Waterloo for fourth highest number of citations per faculty publication in a list of the top 20 institutions in Canada, ahead of a number of other members of the G-13 (Table 14). These results indicate a high degree of knowledge creation and dissemination generated through research by Dalhousie faculty that is of value and relevance to academic peers.

Table 16:
Citations-per-faculty score among Top 20 Canadian universities, from US News & World Report

University	Citations per Faculty
University of Calgary	101
McMaster University	99
University of Western Ontario	92
University of Waterloo	79
Dalhousie University	79
University of British Columbia	78
University of Victoria	78
University of Toronto	75
Université Laval	74
Université de Montréal	72
University of Ottawa	69
McGill University	62
University of Manitoba	57
Queen's University	56
Simon Fraser University	54
University of Alberta	53
York University	36
Carleton University	36
Université du Québec	32
Concordia University	30

Source: World's Best Universities, US News & World Report, February 25, 2010

The real economic significance of the resources devoted to R&D lies not in the spending, but in the results achieved. Results are measured in terms of contribution to innovation, a key determinant of economic and social growth and development.[72]

[72] In its report, *Performance and Potential 2005-06, The World and Canada, Trends Reshaping Our Future*, the Conference Board of Canada notes that innovation is critical to building knowledge and fuelling breakthroughs, but that Canada ranks among the lower-performing industrial countries in terms of R&D expenditures and is losing ground to its OECD trading partners who are not only investing more but are better at extracting value from their R&D investments.

Research on knowledge production provides evidence that the number of citations of scientific publications is correlated with growth (e.g., James Adams's 1990 examination of the quantity of published knowledge and its impact on economic growth). This work is based on theories of economic growth (e.g., Conference Board of Canada, 2005; Romer, 1994[73]) that recognize the impact of R&D and the stock of knowledge on an economy's productivity, innovation and economic growth.

In addition to the direct expenditures made in the local economy by universities in performing their educational and research services, there is an additional impact on innovation, factor productivity and economic growth resulting from the R&D expenditures of universities. The theory traces back to the writings of early economists (e.g., Adam Smith in The Wealth of Nations), who recognized that economic growth would be expected from increases in capital and labour. This includes increases in the productivity of labour through education as well as increased productivity of both labour and capital, referred to as increases in "total factor productivity". The additional productivity stems as a result of innovation or "technical change" resulting from research and development of new products and processes.

A recent study (W. Sudmant, 2009)[74] examines the impact of university R&D expenditures (University of British Columbia) on factor productivity and economic growth. This analysis is based on a methodology originally developed by Fernand Martin (1998)[75] on a national level and subsequently applied as an institutional model to estimate the economic impact of R&D expenditures at the University of California (California's Future: It Starts Here, 2003).

In the case of university research, evidence has shown that there is a causal relation between research and economic growth. There is strong evidence that university research is a significant driver of economic growth in terms of its effects on productivity. McMahon (1993)[76] estimates that 73% of new knowledge generated by university research is transmitted into the economy through university graduates. University professors sometimes collaborate with industry directly, though it is usually via the conduit of other university-educated workers, often with graduate degrees, who facilitate the transfer of knowledge from research to practice.

Dalhousie University is a significant producer of R&D. While it is beyond the scope of this report, and as noted by Sudmant, beyond the scope of current economic research, to provide explicit quantification of the impact or R&D expenditures on innovation, total factor productivity and the growth rate in GDP over time, what is clear is that Dalhousie research makes a contribution to the economy, and that the order of magnitude of this contribution is of significant importance as a driver of the Nova Scotia economy.

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73 Romer, P.M., 1994, The Origins of Endogenouis Growth, Journal of Economic Perspectives 8(1), pp. 3-22.

74 Sudmant, W., 2009, The Economic Impact of the University of British Columbia, Planning and Institutional Research, UNC, September 2009,

75 Martin, F. ,1998, The Economic Impact of Canadian University R&D, Research Policy, Vol., pp. 677-687.

76 McMahon, W., 1993, The contribution of Higher Education to R&D and Productivity growth, in Becker W. E. and Lewis, D.R. (eds.) Higher Education and Economic Growth, Kluwer Academic Publishers, xBoston/Dordrect/London.

VIII
INNOVATION AND COMMERCIALISATION

Canada's leading economists agree that the knowledge economy is becoming increasingly important as the nation's traditional manufacturing sector declines. Leading research organizations, including the Rockefeller Institute, have concluded that universities have become the real incubators of success in North America's knowledge economy. The private sector's role is clear: it must partner with academic researchers in building a stronger, more efficient, greener economy in a region poised for success. University research in turn drives growth of the knowledge economy, which has become vital as the manufacturing sector's competitive position declines in both Canada and the United States. Compared to most competitor nations in the developed world, Canada has established its universities as centres of research and development excellence. Only Sweden tops Canada in R&D spending by universities.

University research is vital to innovation and growth of the knowledge economy

It is in recognition of this new paradigm for economic growth that the AAU, with the support of the federal government, launched its Springboard program (www.springboardatlantic.ca) as a vehicle designed to bring researchers and industry together in pursuit of these goals and promote the commercialization of university research in Atlantic Canada. It is critical that the private sector step up as well – to enter partnerships with university researchers that meet industry needs and advance the region's knowledge economy. Indeed, across Canada - whose private sector trails its major competitors in R&D spending - the universities have stepped up their efforts, often in partnerships with the private sector. There can be no doubt that university-based research is vital to the province's growth and competitive position in the 21st Century.

Dalhousie University plays a key role in Nova Scotia in R&D effort, and is a prime mover in its knowledge economy. Although this has been widely acknowledged, what has been less well understood is the impact on innovation and commercialization as a result of the development of centres of standard excellence and collaborative research networks. This is changing dramatically, as university-based researchers forge ahead with important advances as a result of a collaborative approach to research leading to innovation.

Dalhousie's Industry Liaison and Innovation office plays an important role in the Dalhousie community by bridging the gap between the lab and the boardroom and translating innovation into new endeavours to maximize the potential of research. The impact of university research and development expenditure doesn't end with knowledge creation or dissemination. Often the answers to curiosity-driven research questions bring forth questions related to the application of this new knowledge. The economic value of the commercialization process emerges when new business opportunities arise as a result of translating the research into results. This requires personnel with expertise in finding partnerships, building relationships and leveraging opportunities with both the private and the public sector.

Innovation and applied research at universities can result in patented or licensed technologies and processes. Commercialized research often moves outside the university and takes on a life of its own. These spin-off companies become employers of educated and skilled workers who, in turn, contribute to the quality and growth of industry in the local economy. Spin-off companies

maintain strong ties to the university environment, fostering the innovative spirit of research and development.

Dalhousie's Industry liaison and Innovation (ILI) office is taking the lead in establishing a new funding cycle with the members of Springboard Atlantic. The NRC IRAP program provides smaller enterprises with university-level expertise on R&D projects and industrial problems. NSERC's support for the Intellectual Property Mobilization program allows the ILI office to enhance collaborations with both the IWK Health Centre and the Capital District Health Authority, and emerging spinout opportunities in engineering, science and other fields create more opportunities for local economic growth. The ILI office directly contributed to new research and commercialization funding commitments of more than $4.5 million in 2009-10.

Dalhousie's accomplishments in commercializing research come from the relationships built within the university and throughout the Atlantic region and beyond. The ILI has supported efforts at other Springboard member institutions and national organizations such as MARS (BioDiscovery), the Ontario Research Excellence Awards and the recent Centres of Excellence for Commercialization and Research competition. Dalhousie also led a successful funding effort for the Springboard network in 2008 in the amount of $8.5 million.

Table 17:
Industry Liaison and Innovation, Dalhousie University

Performance Highlights			
	2007-2008	**2008-2009**	**2009-2010**
New Technology Disclosures	**34**	**29**	**47**
New Agreements Registered	**126**	**114**	**156**
Licenses	4	1	1
IPTA	10	15	10
Inter-Institutional	2	0	2
MTA	68	51	80
CDA	27	18	37
MOU	4	1	
Assignment			1
Participation	7	17	16
Research/Collaboration	1	6	4
In-License	2	1	1
Service Contract		2	2
Term Sheet	1	1	1
Revenue Sharing		1	1
Patents Filed	**17**	**17**	**23**
Provisional	8	6	8
Utility or National	4	8	12
PCT	5	3	3
Spin-out Companies	**1**	**0**	**1**
NRC-IRAP Projects	**22**	**32**	**57**
Voucher Program Projects		**15**	**10**
Licensing Revenue	**$622,468**	**$535,923**	**$617,967**
Fees Collected	$579,114	$484,821	$566,196
Royalties Collected	$43,354	$51,102	$51,771

Dalhousie researchers, who own their intellectual property, are increasingly turning to ILI to help translate their discoveries into commercial results. As can be seen in the table above, the number of disclosures has grown to 47 new disclosures in fiscal 2009-10, and continues to be between 30 and 40 per year. Researchers are also benefiting from increased levels of research and commercialization funding at the university. Commercial revenue in the current year has exceeded $900,000, and it is expected that the ILI will surpass $1 million per year in commercial revenue by the end of fiscal 2011. ILI is now poised to be the transmission for the Dalhousie research engine, in turn powering local economic development and prosperity.

The following discussion provides examples of spin-off companies that have successfully commercialized Dalhousie research and will remain in the local economy generating economic impacts for the province. This is not an exhaustive list Dalhousie spin-off companies, and is used only to illustrate the economic impacts of commercialization spin-off companies generated.

- **Thoracic Medical Systems (Thorasys)** – a spin-out company based locally in Halifax, Nova Scotia focused on commercializing an oscillation spirometer used in the treatment of asthma based on Dalhousie research from the School of Biomedical Engineering. The project has involved supportive collaborative partnerships with the Capital District Health Authority and IWK Health Centre. The oscillation spirometer's development was also made possible with support from NSERC, Springboard Atlantic, the Nova Scotia Lung Association and most recently the Atlantic Canada Opportunities Agency, which assisted in bringing the device to market. In 2009, clinical respirologists at the IWK Health Centre and QEII Health Sciences Centre in Halifax, as well as at the Mayo Clinic in Rochester, Minnesota, began using the device in planned clinical studies. Thoracic Medical Systems (Thorasys) is an example of a medical device company that will remain here in Halifax generating economic impacts for the province as a result of Dalhousie research. The founders of Thorays indicated that Halifax is a great location to develop new technology because of the strong research community, with students, faculty and medical professionals all supporting the research required for the commercialization process.

- **BlueLight Analytics Inc.** – a new spin-out company based in Halifax utilizing a novel technological device based on Dalhousie research called *Measurement of Accuracy Resin Curing* (MARC) and translating it into a unique economic opportunity. MARC is a practical new tool to help dentists deliver more effective, longer-lasting fillings. This technology simulates a dental patient to accurately measure the amount of light needed to harden the resin used to fill cavities. MARC uses custom-designed computer software and a simulated patient, complete with realistic teeth, tongue, cheeks and lips, to accurately measure the total energy being delivered to a filling in the mouth. This device has market potential in all sectors of the dental industry, including educators training dentists, dental assistants and hygienists, researchers seeking more accurate findings, manufacturers and clinicians improving their knowledge and skills. Blue Light Analytics Inc. is another example of commercializing university innovation and translating it into a unique economic opportunity for the local economy.

- **Satlantic Inc.** – is a remote sensing company that custom designs, manufactures and sells a wide range of precision sensors and systems for the study of aquatic environments. Satlantic won the 2005 Nova Scotia Exporter of the Year award as well as the Export Growth Through Partnership award. Exports comprise 90% of Satlantic's business, and the company employs 55 people in their Halifax office. The company is heralded as a successful university-industry partnership and has gone on to support further research within the university.

- **Ocean Nutrition Canada (ONC)** – A partnership between a Dalhousie researcher and a local seafood company in Nova Scotia is now contributing to the science of marine-based health and nutrition products. A distillation technology developed by a professor emeritus at the Canadian Institute of Fisheries Technology at Dalhousie University sparked the creation of Ocean Nutrition Canada (ONC), with the help of parent company Clearwater Fine Foods. Now fully spun-out, ONC employs around 300 people in Nova Scotia and has a branch division in Wisconsin, producing the MEG-3 purified fish oil ingredient in nutritional supplements for the global market. ONC continues to research bioactive ingredients from the marine environment in search of other marine natural products.

- **ImmunoVaccine Technologies (IVT)** – Researchers at Dalhousie University created the company ImmunoVaccine Technologies (IVT), to work with the fishing industry to build on its development of a vaccine to control the grey seal population off Nova Scotia. Today, IVT's lab at the BioSciences Centre in Halifax continues to develop and improve animal contraceptive vaccines and the VacciMax vaccine platform (as a quick and effective delivery mechanism), and is involved in trials with Pfizer Animal Health to commercialize the product. IVT also works in conjunction with partners at other universities, Dalhousie Medical School, and pharmaceutical companies conducting pre-clinical trials of human products for the future, employing 14 people, half of whom are scientists.

- **Atlantic Infrastructure Monitoring Inc.** – Researchers at Dalhousie University's Institute for Research in Materials are designing and testing a comprehensive diagnostic protocol for assessing the health of roads and bridges. Using a variety of precision electronic techniques, the team can assess road thickness variation and levels of stress on roads and bridges. Atlantic Infrastructure Monitoring Inc., a joint venture with a locally based engineering firm, will commercialize this assessment technique. Researchers at the Institute have also developed a synthetic material that greatly strengthens concrete and can be used instead of reinforcing steel in some applications. The technology is now being used in Canada and around the world. Technologies such as these can be used to extend the life of infrastructure, improve public safety, and reduce maintenance costs.

The following discussion provides examples of world-class research capabilities, already in place at Dalhousie University, that give Nova Scotia a competitive advantage in this new economic order. Dalhousie's research centres have received national recognition and federal funding as centres of research excellence and the university continues to demonstrate world-class research capacity that has lead to innovation and serves as a catalyst for progressive growth.

- Paralytic shellfish toxins occur naturally in the water column and infect shellfish around the globe. Human consumption of contaminated shellfish can lead to paralytic shellfish poisoning and there are currently no known antidotes or effective medical treatment for this condition. A Dalhousie researcher has developed technology that incorporates unique marine bacteria with the ability to metabolize and destroy PSTs into a commercialisable probiotic product that can be used to detoxify shellfish, making them safe for human consumption.

- A Dalhousie researcher has developed a technology that supports a novel method of processing allograft soft tissue to improve sterility and dampen host rejection of transplanted tissue. It's being developed and pilot tested in close collaboration with Halifax Regional Tissue Bank, at the Capital District Health Authority.

- A new centre of ocean-related research has been opened at Dalhousie University. In recognition of the oceanographic research capacity already in place at Dalhousie, the Government of Canada has awarded Dalhousie institution a new CERC in Ocean Science and Technology. It is led by a Dalhousie graduate, chemical oceanographer Douglas Wallace, who returns to Nova Scotia after working at the Leibniz Institute of Marine Sciences and the University of Kiel in Germany. Over the next seven years, the CERC research unit will research how CO_2 and other greenhouse gases are exchanged between the ocean and the atmosphere and will attract more than 40 new positions to the extensive marine research team already in place at Dalhousie.

- Researchers from Dalhousie University have made great strides in designing catalysts that have potential for commercial use within the industrial and pharmaceutical sectors. Catalysts are materials that cause chemicals to react without changing the properties of the catalyst itself. These catalysts can be used to produce single reaction products that are identical except for their mirror image or optical properties. This controlled method used to achieve the desired chemical reaction is of great interest to industry where 80 - 90 % of chemical processes involve the use of catalysts. The technology recently won an innovation award and the researchers are working with Dalhousie's Industry Liaison and Innovation Office to seek out a potential private sector company to collaborate with and further this research work.

- A Dalhousie researcher has developed a novel technology that involves the excitation of the joint (simply by tapping the pipeline), monitoring the vibration via low cost piezoelectric sensors, and comparing the vibrations to a damage index producing an assessment of the localized damage within the pipeline.

- The Burnside Ecological Industrial Park is an innovative initiative between Dalhousie University's School for Resource and Environmental Studies and the business community in Burnside, the Region's largest industrial park. The project is designed to remedy energy and product waste, minimize the park's ecological footprint, and improve the use of inputs through trade and communal relationships. The Burnside Ecosystem Model assembles a variety of business entities, built through process interrelationships including servicing and materials flow such as waste recovery and recycling, repair, and remanufacturing. Over the past ten years, the Park has continued to strive towards upholding the covenants of creating an attractive and efficient business environment by applying sound planning and management standards.

- Proteomics is a growing discipline dedicated to the molecular characterization of proteins expressed in a biological system. A Dalhousie research has developed a novel device enables rapid protein separation allowing for high protein recovery over a very broad range of protein sizes. Traditionally the health and integrity of pipelines are analyzed by expensive, time-consuming methods such as using ultrasonic scanning or x-rays.

IX
KEY FINDINGS AND CONCLUSIONS

The results of the economic impact analysis conducted in this report shows the Dalhousie University generates substantial economic impacts in the provincial economy, with total GDP impacts of $1 billion, total employment impacts of 10,380 FTEs and total tax impacts of $243 million, based on total direct expenditures in 2009/10. This analysis captures the impacts of university-related expenditures, including impacts arising from student and visitor expenditures as well as research expenditures.

This study also estimates the present value of the marginal tax impacts for the provincial economy based on the incremental earnings of Dalhousie alumni retained and working in the provincial economy. The present value of the total tax impacts for the province of Nova Scotia attributable to the incremental earnings of Dalhousie alumni is estimated to be $2.86 billion over a 40 year working lifetime based on the estimated total number of Dalhousie alumni that are retained and employed in the Nova Scotia economy in 2010 as well as the nature of the degrees they hold.[77] This translates into an average annual tax impact of $71.4 million per year for the Province of Nova Scotia attributable to the incremental earnings (earnings differential) of Dalhousie alumni currently retained and employed in the provincial economy.

This study examines the incremental lifetime net earnings for those holding university degrees in the Nova Scotia economy using 2006 Census data. Earnings differentials make the investment in a university education worthwhile from an individual financial perspective. The average incremental earnings in the Nova Scotia labour force between those with a bachelor's degree and those without is $18,783 per year. However, the average annual earnings differential between those above a bachelor's level and those below a bachelor's level is much higher at roughly $37,000 per year.

When considered over one's working lifetime, these earnings differentials attributable to a university education generate substantial economic returns in the form of incremental cumulative lifetime earnings to the individual. This study estimates the net present value of the cumulative earnings differential associated with a bachelor's degree (over a *"below a bachelor's degree"* level of education), estimated at $277 thousand dollars (using a 3 percent discount factor and adjusting for the cost of university education and the lost income potential while in university). Similarly, the cumulative net returns associated with a degree higher than the bachelor's level is estimated to be roughly $667 thousand dollars over a 40-year income stream.[78]

Our analysis of the Census 2006 data found that almost one quarter (24%) of the working age population in Halifax has completed a university degree at least at the bachelor's level. This is significantly higher than the proportion for the province as a whole (16%) or Canada-wide (18%). While it is not possible to estimate with any precision the contribution of Dalhousie to the educational attainment of the working age population in the Halifax Regional Municipality (HRM), it is clear that it is a major contributor to the significantly higher educational attainment in the local economy. Dalhousie supplies thousands of graduates each year in professions that provide the critical underpinnings for economic growth, diversification and innovation.

[77] Analysis based on a discount factor of 3 percent.

[78] The cumulative lifetime earnings differential is a conservative estimate of the earnings differential attributable to Dalhousie educational programs. The earnings differential is also held constant over the earnings stream.

To the extent that a large proportion of Dalhousie alumni originating from outside the province remain and work in the provincial economy after graduation, Dalhousie university generates large dynamic economic impacts resulting from the retention of higher educated persons in Nova Scotia. These impacts result not only from increased marginal tax impacts associated with incremental earnings of its alumni, but substantial socio-demographic impacts related to the proportionate increase in the university-educated working-aged population, reduced health care costs, increased capacity for savings and asset accumulation, higher incomes during retirement, decreased reliance on Old Age Security benefits, and labour force impacts attributable to the retention of highly qualified persons (HQPs) in Nova Scotia. These impacts fundamentally alter the productive capacity of the province, generating substantial socio-demographic impacts positively affecting the standards of living and economic wellbeing for the province.

A more educated workforce is more likely to possess a greater capacity to develop technologies and innovative processes (resulting in increased productivity) and to have greater capacity to receive and apply new technologies (increased receptor capacity). In addition, businesses are more likely to locate in areas with a higher educated workforce and a larger proportion of HQPs. While the socioeconomic and intergenerational impacts of investment in education are generally omitted when assessing the economic impact of education, the results of the literature indicate that these effects are perhaps larger the market-based impacts of education (margin tax benefits and private returns to education), and therefore should be considered to correctly evaluate the optimum level of investment in education.

Our analysis indicates that Dalhousie is strategically building research expertise in important new fields related to innovation capacity, including materials science, neuroscience, biotechnology, genomics, information management, environmental research, health law, foreign policy, financial services and biomedical engineering.

As the largest comprehensive, research-intensive academic institution in Atlantic Canada, Dalhousie occupies a pivotal role in the knowledge economy for the province of Nova Scotia and Canada as a whole. The university plays a major role in performing basic and applied research fundamental to innovation, economic growth and diversification.

- Dalhousie has built extensive capacity for the local and provincial economy through a diverse range of relevant research programs and activities that reinforce a cooperative, collaborative and interdisciplinary approach to research and education. These processes have fostered research partnerships with regional, national, and international Universities, affiliated teaching hospitals (IWK and QEII), governments and industry.
- The university's research, training and innovation are responding to changing areas of importance to the region and globally.
- In terms of indicators of knowledge dissemination, Dalhousie ranks extremely high in science and engineering publication citations, with a total of 36 Dalhousie faculty members having more than 2,000 journal citations.

The results of our analysis shows that Dalhousie University occupies the central role for conducting R&D in the province, with expenditures on R&D representing a substantial proportion of all R&D performed by higher education institutions and over one quarter (26 percent) of all domestic R&D expenditures in the province of Nova Scotia. The real economic significance of the resources devoted to R&D lies not in the spending, but in the results achieved - measured in terms of contribution to innovation as a key determinant of economic and social wellbeing, growth and development.

Dalhousie's accomplishments in commercializing research come from the relationships built within the university and throughout the Atlantic region and beyond. Dalhousie's Industry Liaison and Innovation (ILI) office plays an important role in the Dalhousie community by bridging the gap between the lab and the boardroom and translating innovation into new market-based opportunities.

Our analysis of the commercialization accomplishments of Dalhousie indicates that the ILI office directly contributed to new research and commercialization funding commitments of more than $4.5 million in 2009-10. Dalhousie has supported efforts at other Springboard member institutions and national organizations such as MARS (BioDiscovery), the Ontario Research Excellence Awards and the recent Centres of Excellence for Commercialization and Research competition. Dalhousie also led a successful funding effort for the Springboard network in 2008 in the amount of $8.5 million.

It is well known that post-secondary education plays a major role in the achievement of high levels of economic growth and development, and to the realization of the broader quality of life benefits associated with it. Economies with higher educational attainment have a greater probability of attracting and retaining businesses to their local economy, more likely to be innovative, develop technologies leading to increased productivity, and more likely to have a greater capacity to receive and apply new technologies.

Dalhousie University plays a key role in the province's knowledge economy. Dalhousie's research centres have received federal funding and national recognition as centres of research excellence. The university continues to demonstrate world-class research capacity that has lead to innovation and serves as a catalyst for progressive growth.

In conclusion, it is clear is that Dalhousie has made a significant contribution to the economic growth of the province of Nova Scotia. The university continues to play a pivotal role in generating the on-going dynamic economic impacts that are critical to achieve the increased productive capacity, attraction and retention of HQPs, and positive socio-demographic impacts (including reduced health care costs) required for the economic growth and prosperity for Nova Scotia in the future.

APPENDIX A: HIGHLIGHTS OF DALHOUSIE'S RESEARCH PROGRAMS

Health Science and Ocean Science remain long-standing areas of research strength and special emphasis at Dalhousie University. Other important research areas include Information and Communication Technology, Energy, Materials Science, and Society and Culture.

Health Science Research

Health Science encompasses the largest area of research at the University and the affiliated teaching hospitals (IWK and QEII) and represents 60% of external research funding and the activities of over 500 faculty members. Dalhousie is the major training centre in the Maritimes for life sciences and health professions research personnel. This area embraces the three Health Science Faculties of Medicine, Dentistry and Health Professions, with other relevant elements found in the Faculties of Architecture and Planning, Arts and Social Sciences, Computer Science, Engineering, Law and Science as well as close working relationships with the Capital Health, IWK Health Centre, Atlantic Health Sciences Corporation and Atlantic Provincial Departments of Health.

The research undertaken involves extensive collaboration with national programs such as the Networks of Centres of Excellence, the Canadian Institute for Advanced Research, numerous network initiatives supported by the Federal granting agencies, three of the National Research Council's Institutes (Marine Biosciences, Biodiagnostics, Nutrisciences and Health), the Dalhousie Medical Research Foundation, the Nova Scotia Health Research Foundation, and the Nova Scotia life sciences industry.

Dalhousie allocates 22 of its CRCs to Health Science research and continues to build research capacity in three main areas: a) genomics, genetics and biomolecular structure and function, b) clinical research and translation to care, and c) health, environment and society. These research areas have extensive interaction and interdependence and are further connected by research in related Dalhousie programs of informatics, bioethics, and health law.

Dalhousie has substantially increased its research capacity in comparative and microbial genomics through the Canada Research Chairs and other programs such as the Evolutionary Biology Program supported by the *Canadian Institute of Advanced Research* and *Genome Atlantic* in collaboration with *Genome Canada* and the *Atlantic Innovation Fund (AIF)*. Research initiatives in this area involve large scale sequencing projects in microbial genomics related to human health, aquaculture, forestry and agriculture, and biotechnology and environmental remediation.

This research also has strong links with bioinformatics (Computer Science) necessary for the extraction of information from large biological databases. The Faculty of Computer Science is developing expertise in handling and analysis of large databases through collaborative research initiatives and new faculty recruitment. The University is building capacity in human genetics and gene identification by taking advantage of unique resources of the Atlantic region for the analysis of genetic defects, particularly those related to neuroscience and vision.

Dalhousie faculty engaged in neuroscience research are closely linked with the development of the *Brain Repair Centre* which develops the tools of functional magnetic resonance imaging, stem cell biology and nerve regeneration to explore brain and nerve function and repair.

Dalhousie and the QEII Health Sciences Centre of Capital Health have major strengths in fetal tissue neural transplantation and in basic research in neural regeneration. Dalhousie has created a new School of Biomedical Engineering (jointly in Engineering and Medicine with assistance from the Faculty of Dentistry) as well as graduate programs in this area. Various initiatives are in progress including a new Tissue Engineering Laboratory. This research has strong ties with the area of Materials Science.

Clinical trials, translational research, health outcomes and health services also represent major research areas for Dalhousie and are undertaken in close collaboration with the QEII and IWK hospitals. The clinical and translational research programs at Dalhousie, in collaboration with the QEII and IWK, focus on the development and implementation of patient-centred, evidence-based medicine. These areas have multi-disciplinary research groups comprising clinicians and biomedical scientists, student researchers, working towards the development of better prevention and treatment, innovative medical technologies and improved models of care.

In collaboration with the IWK Health Centre, and an industry-sponsored research chair, major new developments are underway in vaccine development and testing for a variety of infectious agents. Cancer research is developing very rapidly following a major provincial initiative to improve the entire cancer-care delivery system and increase expertise in fundamental cell biology processes related to development and treatment of cancer as well as improved health systems and the socio-behavioural aspects of cancer care and prevention.

Dalhousie acts as the coordinating centre of several research networks. Research continues in the development of health outcomes research as an integrated collaborative initiative across Atlantic Canada through the development of a network focussed on evaluation of outcomes of health care interventions and health services delivery. The integration of research activities with the collection and analysis of health information by policy makers and catalyzing development of health informatics is emphasized.

Dalhousie, in collaboration with the affiliated teaching hospitals and the Nova Scotia Department of Health and Wellness, is also developing research strength in areas related to social, cultural and environmental determinants of health, population health and health policy. Dalhousie has developed the Atlantic Regional Data Centre to hold Statistics Canada data, in addition to other holdings for population health data. These databases have facilitated numerous initiatives and many links across the university faculties for the study of social, cultural and environmental determinants of health. Dalhousie has established programs for the protection of health through improvements in food safety in the Faculty of Engineering and drinking water through the School for Resource and Environmental Studies, and the Centre for Water Resources Studies.

In addition, many successful joint initiatives between Dalhousie's Faculties of Arts and Social Sciences, Computer Science, Health Professions, Law and Medicine and the affiliated teaching hospitals (IWK and QEII) have been established in the areas of health of children, youths, women, and the aged or frail patient. Informatics, bioethics and health law and information technology in health care delivery is of increasing importance. Several initiatives are underway at Dalhousie involving the health-related Faculties, the Faculties of Computer Science and Engineering and the private sector in relation to enhanced management and provision of health information in rural areas. Research and education related to moral issues in health undertaken by the Department of Bioethics and the Department of Philosophy. The Health Law Institute, supported by the Faculties of Law, Medicine and Dentistry, is also engaged in research related to health law and policy and to the improvement of health care practice and delivery. The following table provides a summary of Dalhousie's research programs in Health Science.

Table A-1:
Dalhousie University's Health Science Research Collaboration

Education	**Research Education Program and Integrated Health Research Training Partnership (IHRTP)** Offering responsive, contemporary educational opportunities for the research community at Capital Health and across Atlantic Canada, the education program has provided standardized training through interactive workshops, Telehealth, Learning Management System modules, presentations and guest speakers. The IHRTP, a partnership among Capital Health, the IWK Health Centre and Dalhousie University Faculties of Medicine, Dentistry, and Health Professions, provides faculty members new to research, undergraduate and graduate students, post-doctoral fellows, research staff, and health professionals the necessary education and skills required to conduct quality health research in increasingly competitive environments.
	Point of Care Research Program A collaborative effort between the Dalhousie School of Health Sciences and Capital Health Research Services, the objective of the training program is to integrate research and patient care through point of care research, combining education, training and mentorship to facilitate the development of a research protocol/project by each participant. Capital Health is also working on strengthening the connection between care and research through its Point of Care Committee. Links to the community are also being made with a with focus group sessions to identify the perceptions and ideas of the public about research.
Ethics	**Research Ethics Board (REB) Harmonization** The goal of harmonization of Atlantic Canada's REBs is to ensure that everyone has access to timely, efficient and high quality research ethics reviews. REB's across the region assist each other with developing review processes and infrastructure through the sharing of resources—research training, standard operating procedures, guidelines and forms. Capital Health will also offer assistance with submission reviews to increase research capacity across the province. Specific discussions are ongoing among Nova Scotia REBs to establish a process which will increase research capacity across the province.
Administration	**Administrative Database** The Research Services administrative database is critical for the comprehensive storage and statistical reporting of research-specific information. Capital Health has partnered with the IWK Health Centre and Dalhousie University in the implementation of a shared administrative database to store research-specific information from all three institutions in a secure, but shared manner. The goal of the shared database is to streamline the administrative processed involved in research, by standardizing terms and promoting collaboration among Capital Health the IWK Health Centre and Dalhousie University,
	Review of Grants Process Capital Health, the IWK Health Centre and Dalhousie Research Services collaborate on, and provide assistance with, grant applications, budget development, application text review and electronic grant application submissions. CDHA, IWK and Dalhousie have developed a standard research grant checklist and accompanying guidelines covering the areas of required certifications, budget considerations and intellectual property (IP) and commercial rights specific to the respective institution. Investigators are required to obtain the necessary authorized signatures and submit the checklist with the supporting grant application. If successful, award notices are forwarded to Research Services at all institutions and each facilitates the opening of a research accounts or required documentation before a study begins.
	Personnel at the IWK Health Centre and Capital Health In order to facilitate the mobility of research personnel working on research studies involving investigators with appointments at both Capital Health and the IWK Health Centre, and when research studies are being conducted simultaneously at both health centres, Capital Health and the IWK have signed a Memorandum of Understanding (MOU). This MOU establishes the criteria and other requirements to facilitate the mobility and work of research personnel at each health centre.

Infrastructure Resources and Planning	**Space—Researchers at Dalhousie University and Capital Health** The diverse nature of biomedical and health research and the emergence of multidisciplinary approaches have led to increasing integration and coordination of all institutions supporting research. New and existing opportunities bring added pressure and urgency to deal with space, a limited resource. As a health research community, we must maximize the use of existing space, create new space and identify resources to allow space to be appropriately configured. Moreover, space planning for research is collaboratively approached among the IWK Health Centre, Capital Health and Dalhousie University.
	Research Methods Unit (RMU) The goal of the RMU is to promote research through the development of shared infrastructure, including data management facilities and methodological support in epidemiology, clinical trials, health economics, health services research, qualitative techniques and statistics. This creates a stimulating training environment, opportunities for interaction among researchers and provides the means for translating knowledge into practice. The RMU is a partnership among Capital Health Departments, the Dalhousie Faculties of Medicine and Health Professions and the IWK Health Centre.
	Sanofi Pasteur Vaccine Challenge Unit This 5,400 sq. ft., ten-bed inpatient unit with single isolation rooms is the first of its kind in Canada and provides a facility for health research that requires inpatient observation and care. The Unit, which is located at the IWK Health Centre, is managed by the Canadian Center for Vaccinology, a partnership of Capital Health, Dalhousie University and the IWK Health Centre.
	Skills Centre for Health Sciences Unique in Atlantic Canada, this 4,000 sq. ft. Centre is a joint venture of Capital Health, Dalhousie University and the IWK Health Centre. It offers a wide range of services, equipments, models and materials that health care professionals can use to rehearse medical procedures, simulate clinical activity and develop communication tools for knowledge translation. There are plans for using the Centre for advanced research purposes such as an environment for device innovation, simulation product development and clinician/inventor collaborations.
National Networking	**National Network—Contracts and Grants** The Capital Health Contract/Grant Facilitation and Support Coordinators, along with counterparts at the IWK Health Centre and Dalhousie University, are active, participating members of CAURA (Canadian Association of University Research Administrators), a national association of individuals committed to advancing the professions; improving the efficiency and effectiveness of research administration at post-secondary institutions, hospitals and other research institutions; maintaining a strong presence and coherent voice on key issues relevant to research; and fostering cooperation and links with other organizations active in management and administration of research. The Capital Health Contract/Grant Facilitation and Support Coordinators are also members of a national list serve of contract and grant representatives from academic and academic-affiliated health care institutions with a discussion form where specific health research questions, information and research are shared among its members.
	N2 Network Capital Health is an active member of the N2 Network which is a national network of academic health organizations committed to research excellence. Membership in this Network enables the sharing of templates, tools, standard operating procedures, and educational materials with institutions across the country and fosters communication among research centres. Capital Health received an NSHRF grant to pay for the cost of member ship for 2009/10.

Life Science Research Institute (LSRI)

The Life Science Research Institute (LSRI) complex is due to open in Spring 2011 and will consist of two interconnected buildings adjacent to the Dalhousie Medical School. One building will house key Dalhousie life-sciences-focused research, including the Brain Repair Centre. The second building will house the Innovacorp BioScience Enterprise Centre. The LSRI offers significant potential for interaction and partnerships between researchers and business, as well as a physical location for incubating ventures that result from this interaction. The LSRI was established through a $15 million federal grant as a centre of excellence focusing on research and commercialization.[79]

Ocean Science Research

Dalhousie has developed an extensive Ocean Science research program that involves more than 100 researchers in 6 faculties, and a wide array of disciplines, including Biology, Chemistry, Earth Sciences, Engineering, Food Science (Canadian Institute of Fisheries Technology), History, Law, Marine Affairs, Medicine, Oceanography, Physics, Political Science, Resource and Environmental Studies, and Sociology and Social Anthropology. Dalhousie has allocated 10 of its 47 Canada Research Chairs to enhance research capacity in Ocean Science.

Dalhousie has established expertise in ocean science research, further reinforced with the recent (2009) award of $45 million from the CFI and the NSERC for the establishment of the Ocean Tracking Network from CFI and NSERC and $10 million for the establishment of a prestigious CERC in Ocean Science and Technology.

The appointment of Dr. Doug Wallace to the Canada Excellence Research Chair in Ocean Science and Technology and as Scientific Director of a proposed new Institute of Marine Sciences, marks the beginning of a new era of Ocean Sciences at Dalhousie and in the region more generally. The ocean-related research programs at Dalhousie and other local organizations will come together under the new Institute of Marine Sciences, moving Dalhousie to the forefront of ocean studies worldwide.

Dalhousie's oceans science research involves substantial collaboration with government research institutes, provincial and federal government departments, as well as international research centres. A major objective of the university's ocean science research is to link the various elements of the University's ocean community with the local community of marine experts in their various Federal and Provincial departments and agencies. Some Ocean Science research at Dalhousie provides excellent training programs for management of ocean resources in developing countries.

- *Ocean Tracking Network* – Dalhousie has established expertise in ocean science research, further reinforced with the recent (2009) award of $45 million from the CFI and the NSERC for the establishment of the Ocean Tracking Network.
- *Canada Excellence Research Chair (CERC)* – Dalhousie was awarded a CERC in Ocean Science and Technology in 2010. Dr. Doug Wallace a chemical oceanographer, will establish and lead the CERC research program valued at $10 million over seven years beginning in August 2011. Dalhousie will add a further $24 million for a CERC Research Unit and is expanding oceans research space in the Life Sciences Centre.

[79] See http://www.ic.gc.ca/eic/site/ic1.nsf/eng/02071.html .

- *Institute of Marine Sciences* – The collaborative approach of the proposed new Institute of Marine Sciences offers the potential to serve as one of the key economic drivers of the region, generating extensive research collaboration and cooperation across disciplines and among institutions -- within Canada and around the world. Dr. Doug Wallace will serve as the first science director at Dalhousie University's new marine research institute, and will play a critical role in establishing long-term research agenda for the university. The Institute of Marine Sciences will bringing together academics and government researchers, serving as a bridge between the marine research community, the private sector and policy-makers, and will provide scientific information for making informed decisions related to oceans.
- The *Centre for Marine Environmental Prediction* (CMEP) – is emerging as a major initiative in the area of marine observation and prediction and involves collaboration with government departments and the private sector. CMEP enhances research on the real-time observation and prediction of the marine environment and promotes the training of highly qualified personnel in this rapidly advancing field. This program is continuing to build capacity for research in marine ecology and biogeochemistry through new recruitments to Dalhousie and expansion of international collaborations.
- Atmosphere processes and climate research in at Dalhousie is strongly supported by granting agencies and government departments. Particular areas of emphasis are aerosol-cloud interactions, climate, and air quality, disciplines that are of great national and international importance. The University is increasing its capacity for remote sensing of the Earth's and other planetary atmospheres from ground-based and space-based platforms through new recruitments.
- The earth system evolution area at Dalhousie is strongly supported by the Canadian Institute for Advanced Research and builds on local research strengths in geodynamics, tectonics, and earth surface processes. This research has important links with the energy theme particularly in regard to assessment of offshore geological structures in Atlantic Canada for petroleum resources.
- Environmental statistics is a growing research activity and capability at Dalhousie that will contribute to, and benefit from, new initiatives such as CMEP. Data assimilation and assessment of the impacts of predicted marine environmental change are two areas of strength and potential for future growth. This area is closely linked to university initiatives to improve capacity and availability of high performance computing resources at the University and through networks such as ACEnet.
- A virtual Centre for Marine Biodiversity (CMB) in the area of endangered species and biodiversity involves collaboration between Dalhousie, the Department of Fisheries and Oceans and the private sector. This research enhances the knowledge, scientific capacity and training of highly qualified personnel in support of the protection of marine biodiversity in the Northwest Atlantic, and provide a focus for structuring independent research efforts toward an overall synthesis of information for integrated ocean management. This research requires interdisciplinary strengths in the areas of Genetics, Physical Oceanography, Ecology, Statistics and Biology.

Research in ocean renewable resources at Dalhousie is strongly supported by the Department of Fisheries and Oceans and Environment Canada, involving research into ecosystem effects of fishing and interactions between aquaculture and wild stocks complement ongoing research activities by the federal departments and are important to, for example, the CMB mandate. Dalhousie is continuing to build capacity in this area through the establishment of Canada Research Chairs and links to international projects such as the Census of Marine Life, the History of Marine Animal Populations, and the development of plans for expanded capacity, through international collaboration, to monitor habitat and migratory patterns of marine species.

The federal Department of Fisheries and Oceans, Environment Canada, the National Granting Agencies, CIAR, and the National Research Council (NRC) provide support for research in biotechnology, genetics and genomics research at Dalhousie based in the Faculties of Science and Medicine, through the Resource & Conservation Genetics and Biotechnology Group (RCGB) and the Genomics and Evolutionary Biology Research Program. Additional research in the area of oceans studies includes the following:

- The *Marine Gene Probe Laboratory*, has established a strong track record in the area of fisheries resource and conservation genetics with strengths in the genetics of population structuring, stock mixing and forensics, informed aquaculture development through pedigree analyses, live gene-banking for endangered populations, and quantifying genetic biodiversity from the level of genes through to ecosystems.
- The Marine and Environmental Law Programme has long been established as a Centre of Excellence in Law of the Sea issues and a world-renowned ocean law and governance program. The Faculty of Law has created the Marine and Environmental Law and Policy Institute as part of the development of this research area,
- Coastal community health and public policy research at Dalhousie includes occupational health and safety issues of workers and communities, safety of marine vessels, and increasingly, projects rooted in the principle of integrated coastal zone management as an enterprise that connects the sciences with the social sciences, engineering, architecture and planning.
- Adaptation strategies and management of the fragile ocean eco-system include processing information for the management of the impact of events such as oil spills or disease outbreaks among fish species.
- Assessment of marine transportation policy and development of methods of risk assessment in such areas as the aquaculture of introduced species or the selection of habitat for conservation

Materials Science Research

Dalhousie has developed extensive expertise and research capacity in this rapidly growing inter-faculty initiative that includes highly respected scientists in the Faculties of Science, Engineering, Medicine, Dentistry, and Architecture and Planning. This research involves a range of new and innovative materials that are fostering many collaborative projects with government agencies and the private sector. Research in this area focuses on structures and properties, and structure and performance, which are linked through the Institute for Research in Materials. Dalhousie has allocated 7 of its CRC to Materials Science research.

Materials Science Researchers at Dalhousie have extensive collaboration with industry, including 3M, Medtronic, General Dynamics and oil and gas industry, as well as with government agencies (Defense Research Development Canada, Networks of Centres of Excellence), and foundations (CIAR, Dunn, Whitaker). Material structure-property relationships and of structure performance research interacts with several other areas of Dalhousie research including Health Science, energy, and information and communication technology.

Dalhousie has developed research capacity and opportunities in structure and performance of materials in the areas of chemical power sources, prevention of degradation of materials, tissue engineering, and intelligent structures and materials.

- Research on chemical power sources is established at a world-class level, while the studies of degradation of materials have special links with the harsh Atlantic marine environment.
- The Faculties of Architecture and Planning, Engineering and Science are involved in research in the innovative and sustainable assembly of new and existing materials to achieve high performance buildings.
- Tissue engineering, under development in the School of Biomedical Engineering, has important connections with Health Science and with the theme of structure and properties.

Information and Communication Technology (ICT)

Dalhousie has allocated 6 of its 47 Canada Research Chairs to support research in ICT research. Dalhousie's Faculty of Computer Science research topics are multi-disciplinary in nature, require multi-disciplinary teams and partnerships, and address complex environments that require the integration of information, computation, and human activity. Considerable emphasis occurs on information processing, information systems, data analysis, networking and wireless technology, privacy and security and human-computer interaction.

- E-Health (electronic health) is emerging as a multi-disciplinary area that addresses how to improve the productivity of patient health care. It is a central focus of Dalhousie's new Global Information Networking Institute (GINI) and current research areas include medical outcomes, quality of service, privacy and patient records, and data compression. The Faculty of Computer Science is building capacity for research in networking since E-health, electronic commerce, and other areas such as tele-learning and tele-medicine, all rely on networking.
- Management informatics, Dalhousie's School of Information Management and the Centre for Management Informatics Research undertake to seek solutions for complex problems in organizational management that effectively engage people and ICT.
- The focus of the research in ICT in the Faculty of Engineering, is on internetworking, digital signal processing, wireless technology, VLSI design and digital communications, photonics and fiber optics. Two of these areas are associated with National Centres of Excellence.

Energy

Energy research at Dalhousie involves collaboration with other Atlantic universities, Petroleum Research Atlantic Canada, the Geological Survey of Canada and NRCan, the Provincial Department of Energy, Nova Scotia Power Inc., and the petroleum industry and associated companies. Dalhousie has allocated 3 Canada Research Chairs to Oil and Gas energy research. Energy research involves four key areas:

- traditional petroleum resources of coal, oil and gas with a focus on understanding the geophysical structures and hydrocarbon reservoirs of the Atlantic offshore;
- energy transportation with emphasis on design and assessment of pipelines;
- alternative and renewable energy sources with an emphasis on coal bed methane and power generation from biomass conversion or wind power; and

- climate change and the environment with emphasis on the effects of offshore resource development and carbon dioxide sequestration in underground coal beds or salt structures.

Additional areas where Dalhousie has developed research expertise include:

- **Society and culture** – Dalhousie has allocated 3 Canada Research Chairs with a focus on European studies. These Chairs act as a catalyst for the Faculty of Arts and Social Sciences to build upon the University's research linkages with the European Union, NATO, the Nordic Council and the UN.

- **Environmental studies** – of alterations to the environment, remediation of environmental damage and the effects of a changed environment is occurring in every Faculty, encompassing the ocean environment, air and water quality, health related issues, management of risk of environmental damage, and legal and social issues associated with environmental changes. Research undertaken by the Eco-Efficiency Centre demonstrates how improved environmental practices can have significant positive financial impacts on organizations, especially businesses.

- **High performance computing** – Dalhousie University is building extensive capacity in high performance computing through partnering with the national high performance computing networks, and in particular with ACEnet, the Atlantic network. This initiative will be achieved through support of ACEnet's activities, through linking with ACEnet and through future initiatives to host ACEnetsupported infrastructure at Dalhousie.

APPENDIX B: DALHOUSIE'S RESEARCH CENTRES AND INSTITUTES

Dalhousie's research centres and institutes include the following:

- Atlantic Centre of Excellence for Women's Health
- Atlantic Health Promotion Research Centre
- Atlantic Institute of Criminology
- Atlantic Research Data Centre (ARDC)
- Centre for African Studies
- Centre for Foreign Policy Studies
- Dalhousie Infectious Disease Research Alliance (DIDRA)
- Dalhousie Inflammation Group
- Dalhousie Multiple Sclerosis Research Unit
- Health Law Institute
- Institute for Research in Materials
- International Ocean Institute
- Law and Technology Institute
- Marine and Environmental Law Institute
- Neuroscience Institute
- Pediatric Pain Research Lab
- Population Health Research Unit (PHRU)

Dalhousie's Technical Research Facilities include the following:

- Aquatron
- Atlantic Region Magnetic Resonance Centre
- Canadian Institute of Fisheries Technology (CIFT)
- Canadian Residential Energy End-use Data and Analysis Center (CREEDAC)
- Centre for Water Resources Studies (CWRS)
- Cosmogenic Nuclide Exposure Dating Facility
- Minerals Engineering Centre (MEC)
- Centre for Innovation in Infrastructure (formerly known as Nova Scotia CAD/CAM)
- Slowpoke Facility
- Trace Analysis Research Centre (TARC)

Other Useful Definitions

- Diploma – refers to any form of qualification - certificate, diploma and degree.
- Earnings – refers to income from paid work, also referred to as employment income.

The annual gross earnings (yearly earnings before taxes) are presented in this document.

- Education or education level – refers to completed education with a diploma.
- High school diploma – includes both high school graduates and individuals who have some post-secondary education but who did not complete the program.
- Low income – refers to a situation in which the income is lower than a level deemed sufficient to meet basic needs.
- Net assets – refers to total assets (including savings) minus total debts (termed net worth by Statistics Canada). Assets include RRSPs, employer pension plans, financial assets, non-financial assets (principal residence, vehicles and belongings like major appliances, furniture, valuables and collectibles) and equity in business. To obtain net worth, debts such as mortgages, lines of credit and loans are subtracted from assets.
- PSE – post-secondary education; refers to education after high-school.
- Post-secondary diploma – refers to all forms of certification from a trade, vocational, college (including Cegep) or university program.
- Trade diploma – refers to both trade and vocational education completed.