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Measuring the Economic Impact of Postsecondary Institutions – Appendix

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Appendix A – Summary Table of Economic Impact Analysis (EIA) Metrics and Methods Used in the Postsecondary Education (PSE) Context

Table A.1 presents a short summary of major metrics and methodologies, along with their major advantages and disadvantages.

Table A.1 Summary of EIA Methods and Metrics

Method	Types of Impacts Addressed	Pros	Cons	Comments
Spending and re-spending – local economic activity				
Basic Input-Output (I-O) analysis (from analysis of expenditure data, using provincial stats groups)	Ripple effects of PSE spending in the local economy (direct indirect, and induced impacts, GDP effects, jobs)	Easy to do Often convincing to policy-makers	These "upstream" impacts do not in any way reflect the success of PSE activities	Very commonly used, partially because "multipliers" often confused with profit
Value-add I-O methods (from analysis of expenditure data, using provincial stats groups)	Similar I-O impacts but related to likely effects of major new initiatives (e.g., anticipated visitors and their spending)	Partially address likely "downstream" impacts and often include attraction of external spending to region	Often used simply to justify these planned expenditures	Estimated success of these initiatives is not followed up on
Highly qualified personnel (HQP) impacts				
Near-term impacts (from surveys and/or from literature)	Expenditures in local economy, I-O impacts, "job creation"	Same as for I-O analysis	Same as for I-O analysis "Job creation" usually just means FTEs of teaching assistants, research assistants, etc.	Same as for I-O analysis
Mid-term impacts (from StatsCan data, surveys and/or literature)	"Education premium": wage/salary increment gained by graduates, tax implications	Easy to do from published data	Not specific to institution unless customized to program offerings Significant HQP self-selection and attribution problems	Very commonly used Colleges more likely to customize to program offerings

Method	Types of Impacts Addressed	Pros	Cons	Comments
Mid to long term (from literature)	Collateral social savings – Reduced likelihood of significant societal problems (e.g., crime, unemployment)	Relatively easy to do from published data	Not specific to institution Significant HQP self-selection and attribution problems	More commonly done by colleges
Long term (from case studies, follow-up surveys of alumni and/or their employers)	Contribution to knowledge economy, impacts for local industry, government, society	More rigorous and defensible analysis of success of HQP training Includes true job creation Institution-specific	Time- and resource-intensive Still some self-selection problems (though lesser)	Rarely attempted but results often quite striking
"Downstream" impacts from using research findings and expertise				
Immediate impacts on knowledge production (from bibliometrics)	Publication volumes, proxies of quality (e.g., Average Research Impact Factor (ARIF))	Easy to do Institution-specific	Only very indirectly related (if at all) to economic impacts	Sometimes included in EIA reporting for more complete picture
Near-term traditional indicators of commercial activity (from institution's internal metrics)	Patents, licenses, royalties, number and value of research contracts, strategic research consortia, etc.	Relatively simple, most data available from Office of Research Services and/or UILO Institution-specific	Measures traditional technology transfer (TTT), direct routes only Over-emphasis can divert attention from more important non-traditional modes of impact No assessment of eventual dollar values	Very common methods and metrics

Method	Types of Impacts Addressed	Pros	Cons	Comments
Non-traditional indicators of commercial activity (from case studies, interviews, institutional and corporate “success stories”)	New value chains, improvements to human capital or internal corporate R&D capability, new policies or professional practices, better decision-making or strategies, etc.	Value of these routes often equal to or more important than TTT Institution-specific	Time- and resource-intensive Metrics rarely tracked by ORS or UILO Often challenging to value in dollar terms	Frequently most useful to consider impacts of long-term programs of work Relationships of researchers with end-users often critical
Ultimate impacts for industry – Type 1: from bottom-up specialized case studies such as Outcome Measurement Studies (OMS), partial benefit-cost analysis, based on “big winners”	Increased net revenues, net cost savings, new markets, etc.	PBCA provides solid lower bound estimate of net benefits; other methods can be nearly as rigorous if follow-up done Institution-specific Can track both direct and indirect routes to impacts	Time- and resource-intensive “Big winners” only sometimes tracked by UILO, identification can be difficult (big winners often not recognized by researcher or institution)	Frequently most useful to consider impacts of long-term programs of work Relationships of researchers with end-users often critical
Ultimate impacts for industry – Type 2: from top-down methods such as GDP impacts, based on literature on total factor productivity	Increased national productivity, GDP, associated with assumed use of R&D findings	Easy to do, as based on published data Provides high estimates of impacts	Not institution-specific Very difficult to understand underlying methodology and to assess validity of assumptions	Impacts usually estimated at national level, not provincial or regional Frequently used by universities
Ultimate impacts for industry – Type 3: from retrospective studies of how innovations arise	Increased net revenues, net cost savings, new markets, etc., generally sector-specific	Combination of quantitative and qualitative assessment of R&D impacts Can address synergistic roles of multiple institutions	Very time- and resource-intensive	Tends to assess impacts of R&D done decades in the past, not necessarily of most relevance now

Method	Types of Impacts Addressed	Pros	Cons	Comments
Ultimate impacts for industry – Type 4: from case study analysis of cluster development, possibly through specialized surveys	Increased net revenues, net cost savings, new markets, etc. Recent studies focus on human capital development	Combination of quantitative and qualitative assessment of R&D impacts Can address synergistic roles of multiple institutions, and factors that facilitate/inhibit	Time- and resource-intensive Metrics rarely tracked by ORS or UILO Some studies only use general sector statistics and are not institution-specific	Attributable role of PSE may be difficult to identify but likely very important
Larger societal impacts – Type 1: from case studies, interviews, institutional external "success stories", including payback mixed method studies, Social Return on Investment	Public good impacts on community sustainability and well-being, individual and public health, the environment, etc.	Important part of PSE mandate Potentially very important transformative impacts	Time- and resource-intensive Metrics rarely tracked by ORS or UILO Often challenging to value in dollar terms	Frequently most useful to consider impacts of long-term programs of work Relationships of researchers with end-users often critical
Larger societal impacts – Type 2: from econometric analysis of the economic activity sustained by *spending* on research and measures of the *benefits* of research to its users	First component similar to I-O impacts Second component more revolutionary – valuation of research mediation activities by end users	Recognition that outputs tend not to be embodied in products or codified knowledge and thus require mediation of interpretation by experienced researchers Monetization of impacts	Assumptions underlying second component methodology contestable Methodology difficult to apply	Methodology developed by London School of Economics
Health care impacts (from Payback Framework methods)	Five categories: knowledge, benefits from research, benefits from better policies, health & health sector, wider social and economic	Can be as rigorous as desired on economic side Mixed qualitative and quantitative assessment	Time- and resource-intensive Metrics rarely tracked by ORS or UILO Often challenging to value in dollar terms	An analogue of specialized case studies such as OMS and PBCA but focused on health and health care system impacts

Appendix B – Detailed Discussion of Metrics and Methods

B1. The Measurement Challenges

B1.1 Context

Measurement of the economic impact of postsecondary institutions has become commonplace; what is not so common is consistency of methodologies, terminology, and an understanding of what is and is not revealed in such assessments, nor how best to illuminate the unique contributions of individual institutions.

While there is significant international diversity of approach, many Canadian universities (not colleges) have used either the same EIA methodology or small variants of it – that championed by Sudmant (UBC, 2009). These approaches are now routinely encountered among Canadian EIA studies. While the rationale given for using the same EIA methodology among Canadian universities is ostensibly comparability by external/provincial decision-makers, there is also a strong drive for inter-institutional benchmarking as there is an understandable desire of institutional leaders to compare their institution with others of comparable size.

At a macro level, the comparative picture in these routine approaches is reasonably valid for those elements that are captured in the methodologies recently used by several Canadian universities – e.g., (1) the economic impact of institutional, student and visitor spending, (2) the regional educational premium associated with higher earnings of graduates, and (3) a proxy measure of the likely impact of research activities on local industrial productivity, based on average factors taken from the literature. Impacts #1 and #2 are, however, transactional or turnover measures that could be applied to many different types of entities (e.g., museums, sports facilities) and do not reflect all of the specific missions and activities of postsecondary institutions. Impact #3 has a more direct alignment with the mission of a postsecondary institution, but it is usually based on average factors[1] (rather than institution-specific impacts) and its interpretation requires an understanding of the underlying economic assumptions. It also does not provide a complete approach to an institution's economic impact.

Making the overall picture more complex, the EIA methodologies employed by colleges tend to be more diverse, with particular attention to their impact on specific sectors of the economy.

Impacts of particular relevance to policy analysts and government decision-makers are the value-added aspects of the teaching, research and service mandates, including the regional impacts of the institution. Most EIA reports from universities do not capture impacts that are unique to an individual institution's programming alone. Ideally, application of the macro-level EIA would be accompanied by "micro-scale" [2] and/or "meso-scale"[3] data that can be captured using some of the other techniques discussed in this paper. The critical aspect of these additional indicators is that they are specific to the actual institutional activities and not proxies based on generic algorithms from studies that are often done in different contexts.

[1] Such average factors employed in EIA studies include data on average incomes by level of education; employment by level of PSE attainment; and average spill-overs to industry from university research. These are usually derived from national-level investigations.

[2] For example, at the project or individual lab level.

[3] For example, at the facility, research theme, or faculty level.

B1.2 Overview of postsecondary impacts

There are significant difficulties associated with simply identifying – much less measuring – impacts in the postsecondary education (PSE) sector because of their sheer number and complexity. The easiest to identify and quantify are quite well served by the “routine” EIA methods. However, a tremendous portion of the value added by postsecondary institutions arises through indirect and non-linear routes (e.g., unintended benefits in unanticipated disciplines and sectors), often over very long timeframes, and frequently through routes that are unexpected and even completely unknown to the institutions and their faculty, including contributing to greater community cohesion and social inclusion (see also Appendix E). A (very) short list of ways in which postsecondary institutions can effect economic impacts is through:

- *Spending and re-spending* in the local community and nearby region, generating local economic activity;
- *Training highly qualified personnel* (HQP) at all levels[4] who go on to generate economic impacts directly through their own work for employers (e.g., through increased productivity), by creating new start-up businesses and/or through broader knowledge and technology transfer to their employers and employees, colleagues, community, etc.;
  - *Collateral social savings* – e.g., lower tax rates through improved health, lower social assistance and unemployment, and lower crime that are assumed to result from a more highly educated population;
- *Conduct of research and development* (R&D) projects that have practical applications for Canadian industry and society, for example through application of the research findings (e.g., in new products or processes, better policies and regulations, improved health care protocols), or through use of the expertise developed by the research partners (e.g., increased industrial R&D “know-how”, better business strategies, new partnerships and supply chains);
- *Strategic interactions between the postsecondary institutions and the broader community* that foster and enhance diverse impacts such as improved social equity or better decision-making, all of which may eventually lead to economic impacts such as lower costs, development of new business enterprises, stronger linkages within value chains, etc. Such mechanisms include:
  - support for knowledge and/or industry cluster development;
  - community partnerships and community building;
  - development of knowledge and technology clusters;
  - discovery parks;
  - university-industry, university-government and university-not-for-profit linkages;
  - co-op and entrepreneurial programming;
  - service learning; and
  - cultural amenities.

[4] Undergraduate, master’s, PhD, postdoctoral fellows (PDFs), technicians, research associates, diploma programs, trades certificates, etc.

Within each of these broad routes there will be benefits that arise in the immediate, mid and long terms, through both direct and indirect routes, and through feedback loops from the postsecondary to the external community and back to research and training activities. Thus the methodologies used to measure these impacts run the gamut from the easy (addressing direct, short-term impacts) to the complex (the opposite).

Further complicating these problems is that there is no single, well-accepted and consistent terminology in the field. Even the term “impact” means different things to different people and as used in different methods. Other terms such as “benefits”, “direct”, “indirect”, “inputs” and “outputs” similarly have varying specific definitions according to the methodologies being discussed. Even “economic” means different things to different authors and in different methods[5], and even the same authors in different studies. In section B.2 we provide some simple definitions of these terms for the purpose of discussion, recognizing that other studies may differ in these definitions.

B1.3 A typology of benefits for consideration

While our study team believes in the value of assessing the outcomes and impacts of institutional activities, it is less fond of methodologies that make all institutions look like variations of each other and do not reveal the distinctive elements of each. Such studies provide little in the way of value-added information for either the institutions themselves or for policy makers. Essentially the impacts from such studies (primarily the traditional input-output (I-O) studies discussed in section B2.4 and B3.2) are very highly correlated with the institutions’ expenditures – once you know the impacts of one, the reader can fairly accurately extrapolate the impacts of another, simply based on their ratio of operating funds.

We address the methodologies and inferences of these core I-O studies as they will continue to be an element of all EIA. And while those more generic methods are certainly useful for providing baseline information on important impacts, we have especially focused on methods that emphasize the distinctive contributions of individual institutions. However, just as there are many types of economic and societal HE benefits, there are many ways of categorizing and defining them, and being able to do so in a sensible way is the first step to devising ways of measuring them. For this reason, the study team advocates attention to articulation of the intended economic impacts as a precursor to measurement.

A well-known approach to framing impacts is through the development of a logic model. Logic models show the linkages among inputs, activities, outputs, outcomes and intended impacts (see section B.2 for more on what an “impact” is). They are usually presented as a graphic and provide a useful framework for assessing:

- The true logical structure of the planning and programs of the organization in the context of its intended outcomes and impacts:
  - This is addressed by considering whether the “logic” shown is in fact actually logical.
  - The study team notes that logic charts too often are used simply to demonstrate justification for existing programming. However, they are more useful as an analytical tool to identify strategic and

[5] For example, in HEQCO’s paper *Informing the Future of Higher Education* (2011 HEQCO Community Report), the terms “input” and “output” mean different things from the same terms used in Input-Output economic estimation techniques.

programmatic gaps and opportunities, rather than just as a "feel good" document to justify your program.

  - Pretend you are from Mars. Is the logic actually logical? Are there outcomes that will never happen because a critical support mechanism is missing? Is there a tremendous opportunity for important outcomes or impacts that no one has really thought through or developed a concrete strategy for? Are there weak linkages in some parts of the logical chain? Are there gaps in the logic or opportunities to add stronger linkages?

- Possible ways of monitoring, evaluating and reporting on performance:
  - For many individual elements within the logic chart, it will usually be possible to identify one or more approaches to assess the presence and magnitude of success for each link in the logical chain. And if the logic chart is complete enough, all important elements will be addressed, at least conceptually.
  - However, while some elements of the logic chart will be quite easy to measure, the measurement of others will be quite challenging. Some metrics will likely be challenging to the point of near-impossibility.
  - This analysis can then be turned into sets of metrics of varying complexity and ease of study. The core set might be easily and routinely collected but not terribly informative (e.g., mainly upstream impacts), while a more complex set might only be addressed in a special study every few years (e.g., to provide illuminating evidence on downstream impacts).

In addition to identifying small-scale tactics that might best lead to the intended impacts, a logic model framework is also an effective way of illuminating the relationships of the higher-level organizational strategic goals with the assets and activities necessary to achieve those goals. The highest level of goals for a postsecondary institution would be the socioeconomic and cultural impacts that derive from its educational, service and research activities, and these would be illuminated in some detail in the logic chart. One could then, for example, ensure that the institution properly supports all important facets of these impacts. A cautionary note: any system of metrics should do all possible to avoid adverse behavioural influences, something that can happen when metrics focus on what is easy to measure, not what is important (see additional discussion in section B9.4).

As an example, the recent agreements between Ontario and its postsecondary institutions on agreed areas of specialty[6] (Strategic Mandate Agreements) provide a particularly rich basis for articulation of institutional logic models, even though these are still rather generic. At the same time it is important to remember that logic models are not static. They evolve with the climate in which the organization is situated. Further, the study team notes that logic charts are too often used to simply justify existing programming – everything looks quite logical, even if it is not. They can add more value when used in the analytical sense described above.

Even without a formal logic model structure, there is benefit in articulating the "universe" of benefits expected from a postsecondary institution's activities to frame an EIA. In Appendix E we have taken a recent Canadian university framework and made some substantive modifications to be more inclusive, rather than

[6] Globe and Mail, Friday, Aug. 08 2014. Ontario unveils deal with universities, colleges to specialize programs

exclusive, of the various types of impact that institutions, HEQCO and the Ontario government might want to address in one way or another.

B2. Terminology

B2.1 Overview

Terminology in the EIA field is complex, frequently contradictory, and usually quite confusing. Many organizations define “impacts” very loosely and different types of studies use different definitions (either formal or implied).

There are two main types of terminology used: as adapted from the program evaluation field and from input-output methodologies. In evaluation jargon, impacts are found among things that happen, for the most part, along a time continuum and as related to the success of postsecondary activities. We will mainly employ evaluation-related definitions here except where specifically noted. In input-output jargon, impacts are things that happen – again, for the most part – in the relatively immediate present and as related to the expenditures made, whether the postsecondary activities are successful or not.

Furthermore, different disciplines refer to the mechanisms for achieving impacts in different ways. The natural sciences and engineering commonly talk about “technology transfer” but less commonly refer to “knowledge transfer”, while the health sciences discuss “translation” and the social sciences typically refer to “knowledge mobilization.” Of importance for us is that it does not matter how impacts occur, only that they actually do so – but explicit recognition of the various routes through which this happens can be critical to identifying and measuring those impacts.

B2.2 What is an “economic” impact?

First, we discuss how economists consider if a certain impact is “economic” or not. An impact is an “economic” one if it comprises the creation of “worth”: goods, services, concepts, ideas, feelings, etc. that someone – anyone – is willing in some way, even hypothetically, to pay for. These items do not actually have to be for sale and consumers or the public do not actually have to pay for them in order for them to have worth or to be considered “economic.” It only requires that their worth might conceptually be measured in dollar terms, if one could think of a way in which dollars might be paid for the positive impacts or to avoid negative impacts.

- Obviously goods and services which are in fact sold and purchased, have worth; their worth is at least what they sell for.
  - They might actually be worth more than the sales price if consumers or the public would hypothetically be willing to pay even more for them than the actual sales price.[7]
- Cost savings are also “economic”, even if the route to achieving them is somewhat indirect.

7 An economist would call the differential “consumer surplus.”

  - For example, one might assign a monetary value to the correlation of the higher level of education of all graduates from a postsecondary institution with regional benefits, such as reduced crime, reduced health care costs, higher productivity and reduced reliance on social assistance.
- More difficult to value in dollar terms is a wide variety of impacts such as improvements to health, safety, the natural environment, national or personal security, confidence and so on, many of which would be considered in the "public good" domain.
  - Even here, however, these impacts would be considered "economic" if one could determine that the public is hypothetically willing to assign a dollar value to them.[8]
  - Many impacts of this kind are what economists term "non-appropriable", meaning that it is difficult or impossible for the individual organization that conducts the work to be the only organization that benefits from it (i.e., "appropriates" the benefits). This is one reason that it can be difficult to convince the private sector to conduct the R&D.[9]
  - Note also that there are usually many intermediate effects leading to these "dollar" impacts. For example, the postsecondary institution may foster better industrial or government productivity, develop an improved innovation model for external organizations, provide external parties with a better trained workforce, or help create new firms or valuable government or societal agencies that would otherwise not exist. The existence of these effects, while important precursors, would not normally be considered the ultimate economic impacts – it is the dollar impacts arising from them that are most important. (One can easily see why. Imagine an innovative new firm which fails in the marketplace and goes bankrupt. The proof is in the pudding, as it is said!)

The point here is that "economic" – at least to an economist – can mean far more than the simple trading of dollars for goods and services. Sometimes the term "socioeconomic" is used to imply that societal impacts do in fact have a real economic component and real worth. Having said this, in this paper we mainly discuss impacts that can be relatively easily and understandably measured in dollar terms.

B2.3 Evaluation terminology

Evaluation terminology is useful in that it usefully separates different components of a value chain to clarify exactly who is doing what, and how and when. Additional detail is provided in Appendix D.

- **Activities** – These are the "upstream" things that the institution or an individual program does as an organization. Activities are always "internal" to the institution or its programs. Often "inputs" such as research revenues are tracked within this category.
- **Outputs** – These are the immediate products resulting from these institutional or program activities. They are also usually internal to the institution or its programs.
- **Outcomes** – These are what results "downstream" from using the research, training, outreach and other

8 This can be quite challenging but various techniques can be employed; e.g., "willingness to pay" (how much would you pay for this impact if you absolutely had to pay for it) or "willingness to avoid" (how much would you pay to avoid this effect if you absolutely had to pay for it). These methods are rather cumbersome but useful when decisions need to be made as to how public monies should be spent, as they put different kinds of impacts on an equal dollar footing.

9 Similar problems occur for broad societal costs such as those resulting from industrial pollution; the true societal costs are not borne by the polluter.

outputs. The outcomes of interest are generally (though not exclusively) “external” to the institution or a given program.

- **Impacts** – These are how those outcomes affect society. These are virtually always external to the institution and its programs/initiatives.

The evaluation terminology and framework (also employed in a logic model) is of particular importance in assessing institution-specific impacts that go beyond input-output methodologies. It is also very relevant in the conduct of partial benefit-cost analysis (PCBA) studies that are discussed further below.

B2.4 Input-output terminology

Many economic impact studies use some form of Input-Output (I-O, or I/O) methodology as a tool for measuring the economic impact of the institution’s activities. I-O studies are discussed in more detail in section 4.2 but are very popular as a relatively quick and easy way to assess certain important economic impacts, especially the nearest-term ones. Unfortunately the “I-O impact” terminology is quite different from “evaluation impact” terminology, so a brief discussion may help understand the differences.

I-O studies essentially estimate the ripple effects of a given organization’s spending in the local economy. In some I-O studies, there are additional analyses that reflect the results of the spending and investments brought to the region by specific initiatives (e.g., hosting conferences and visitors). In all I-O studies, however, “impacts” are estimated. These “I-O impacts” are quite different from “evaluation impacts”:

- “I-O impacts” reflect the local economic activity that results from <u>*expenditures*</u> made by (in our case) universities and colleges as they produce their goods and services, as this spending ripples through the local and regional economies;
  - It is far less important what the money is spent on than where it is spent. Local spending results in higher direct impacts (where the money is initially spent) and indirect impacts (where the support and supplier industries providing goods and services are).
- “Evaluation impacts” depend critically on the <u>*success*</u> of the institution and its various initiatives, especially as one thinks downstream over the mid to long term;
  - For example, two training initiatives that attract equal numbers of students result in equal expenditures by those students in the local economy and purchase equal values of goods and services in the local economy to conduct the training will both have exactly equal direct and indirect “I-O impacts.”
  - If one training program, however, produced great numbers of highly skilled HQP who go on to create a vibrant industrial cluster that transforms the local economy, while the other program has very few graduates (and those who graduate never use their skills in any meaningful way in the knowledge economy), the former will have tremendous “evaluation impacts” while the latter would be considered an “evaluation failure.”

Some I-O studies use hybrid methodologies that go some way downstream in attempting to fill this gap[10], but I-O and evaluation come at the "impact" question in fundamentally different ways. Unlike evaluations, I-O studies do not provide insights on the rationale for the expenditure of public funds on PSE as opposed to other possible programs.

B2.5 A messy lexicon

There is an amazing gamut of complex terminology employed in economic analyses, especially those that go beyond the pure evaluation and I-O approach. The use of compound indicators, often with slightly different underlying assumptions or components, can make comparison of methods difficult (and often impossible, if sufficient detail is not provided regarding assumptions and calculations). The discussion above provides a few basic definitions of some of the most extensively used terminology within the EIA field and within the text of this document for each methodology outlined.

B2.6 Where you stand depends on where you sit

In addition to the inconsistent use of terminology in the EIA literature, where a given actor stands in the continuum affects how a given factor is perceived (and its corresponding terminology). For example, grant funding is an "output" of the university granting councils but an "input" to the researchers and institutions receiving it; while patents are "outputs" of university actions, they are "inputs" to the companies using them; and similarly, increased industrial R&D capability based on hiring HQP is a university "outcome" but forms the basis for additional "activities" by the companies hiring them.

- The key thing to bear in mind when considering your "impacts" is that one ideally tries to measure as far downstream as possible and consider as many impacts external to your institution as possible. It is these external impacts for industry and society that are of most interest to the general public and policy-makers.

Finally, in real life these effects do not proceed in such a straightforward and linear manner, and there are many feedback loops; e.g., external impacts for industry often suggest important new basic research problems. In addition, some outcomes and impacts happen in the relatively short term, others in mid to long terms.

B2.7 Methodologies versus indicators and metrics

There is one last distinction worth mentioning: what are metrics and indicators versus methodologies?

- "Metrics" are ways in which you will assess the presence and magnitude of each impact of interest.

[10] For example, assessing the likely future higher earnings of HQP indirectly measures the training program's success – the more successful the program, the higher the percentage of graduates and the higher the salary supplement for graduates. However, even here one would ideally use factors that are specific to each given institution rather than using a proxy value that reflects the average success across multiple institutions. I-O studies typically use the latter.

- In thinking about metrics, one first thinks about what types of impacts are of interest – in essence, what do you want to achieve?
- For example, an institution may decide that one important impact is to improve the Canadian economy through (in part) applying the institution's research.
- Specific metrics associated with this impact might include the change in Canadian industrial revenues attributable to use of that research, the number of new Canadian start-up firms in that field, the number of jobs created as a result, growth in the local industrial cluster, etc.
- These are sometimes also referred to as "indicators" and (as so often) different authors employ different terms.
- Some metrics/indicators may be quantitative (e.g., change in sales revenues) but others may be qualitative (e.g., expert opinions on how strong the local cluster is).
- There is a tendency for quantitative measures to be called "metrics" and qualitative ones to be called "indicators" but this usage is far from consistent.

- "Methodologies" are simply the ways that you might obtain data on these metrics/indicators and the ways in which the data might be analyzed.
  - One might use interviews, case studies, surveys and Statistics Canada tables to obtain data on sales revenue, for example, and then use one of a variety of benefit-cost techniques to analyze those data.

In this paper, we discuss both metrics and methodologies, trying to clarify the distinction where they are not self-evident. We also use the terms metrics and indicators interchangeably. While particularly focused on impacts (i.e. performance metrics), output, process and directional metrics can also be powerful components of an economic impact toolbox.

B3. Overview of Economic Impact Analysis: Impacts and Methodologies

B3.1 Overview

To summarize a very complex environment, postsecondary institutions can quite easily do basic "bread and butter" I-O studies that have been well-accepted by the academic community and government funders in the past. However, these mainly depend on identifying the "local spending" impact of having a college or university in a given region and apply almost equally well to any postsecondary institution or, for that matter, any non- postsecondary enterprise that spends money in the local region.

Many of these studies include some additional analyses related to impacts of training and research that help identify the essence of what you expect from postsecondary institutions: the production of skilled graduates who can make businesses hum; the creation of knowledge through research that can be turned into innovative products or processes; and the general bettering of the community's functioning and society in general. Unfortunately, many techniques used rely on generic techniques that miss many important impacts, do not go very far downstream and do not distinguish among individual institutions or important initiatives. As these training, research and societal factors are the true economic drivers associated with PSE, the study team presents some alternate methods that we hope will stimulate innovate ways to think about and measure them.

B3.2 Spending and re-spending impacts in the local economy

B3.2.1 Local impacts of re-spending

Impacts and metrics. University expenditures ripple within the local economy and these impacts are typically measured using Input-Output (I-O, or sometimes I/O) methods.[11] This is an example of using metrics mainly related to "upstream" economic factors within the PSE sector; i.e., those mainly associated with budgets and expenditures. I-O and related economic impact analyses (see below) do not attempt to measure or quantify the success of the institution in achieving its goals, or its societal or public good impacts.[12]

A typical I-O study will estimate the direct, indirect and (sometimes) induced impacts of an organization's effects on the local economy, for which the key metrics are:

- **Direct impacts** are caused by the institution's primary expenditures and other economic activities that allow it to produce its various services; in most cases they can be thought of as the goods and services the institutions purchase in the local economy (e.g., the institution hires faculty members and staff who live in the area, constructs new buildings using local contractors, maintains facilities using local service firms, etc.);

[11] What is considered "local" depends on the study being done but is defined as part of the I-O methodology. It might be the specific city or town in which the institution is sited, for example, or a broader metropolitan area surrounding it, or even the entire province or country.

[12] They are, however, sometimes used to estimate the impacts of "soft" factors such as changes to community structure, legislation or regulations, so long as these are easily quantified in dollars.

- **Indirect impacts** are created by the support and supplier industries that provide those goods and services to the institutions (e.g., the local contractor purchases most of the construction materials and hire most crew from the local region, but some specialized equipment or expertise might be sourced internationally); and
- **Induced impacts** related to general local, regional or national economic growth arising from the direct and indirect expenditures. These generally refer to the economic effect of new jobs and additional household incomes within the economy as employees re-spend a portion of their income.[13]

In addition, most I-O studies also include a metric that estimates the number of jobs supported (again, on a direct, indirect and induced basis), as well as local, provincial and federal taxes that result. All of these short-term effects are clearly and linearly related to the main business of universities and colleges, and their magnitude is mainly affected by where the goods and services are purchased and the structure of the local labour economy. To simplify (considerably), there are more local direct and indirect ripples if institutions source their supplies and labour from local sources. (Induced impacts increase if these employees and suppliers believe the economy is sufficiently robust and safe that they re-spend a portion of their fees and wages locally.) The first factor is affected by the institutions' strategic business decisions as well as (of course) the availability of appropriate local skills and products to meet its needs. The second factor is little affected by institutional strategy.

Methodology. The calculations done for I-O analysis (i.e., the methodology) are typically done by a firm that specializes in collecting and analyzing the appropriate expenditure data, supplemented by analyses done by provincial statistical divisions.

B3.2.2 Multipliers

The sum of direct and indirect impacts together, as compared to the direct impacts alone, reflects the "multiplier" effect of the expenditures within the local economy. For example, if $1.00 of an institution's direct impacts results in $0.60 of indirect impacts, then the multiplier is 1.60. If $0.40 of induced impacts is also included, then the total multiplier is 2.0 – the total direct, indirect and induced impacts are twice the direct impacts alone.

> ***Note that this does not mean that the institution has a* profit ratio *equal to these multipliers. The multipliers simply reflect how much the primary spending recirculates in the local economy.***

Various types of multipliers can be calculated (e.g., on outputs, spending, employment, income, Gross Value Added) that are beyond the scope of this paper, but all rely on estimating these "ripple" effects.

[13] Induced impacts are not always included in the analysis as their existence is based on assumptions that are difficult to assess, especially with respect to the origins of workers who fill new job positions and whether they will leave the region if the job ends. (Some consideration of consumer preferences and spending is also ideally required.) It is also rather easy to double-count induced impacts, leading many analysts to only include direct and indirect impacts. Of course, this leads to lower multipliers. Without going into details, the presence of induced impacts can be more easily justified where highly specialized job positions or initiatives, or large capital expenditures or exports, are involved.

The detailed analysis can be quite complicated if the analyst attempts to track the detailed local *vs*. remote expenditures for all the various components of the total. For example, the analyst might be able to use a standard set of multipliers[14] for various materials and services needed to construct a student dormitory but might need to investigate the detailed expenditures for a "Big Science" project in detail, as they are unlikely to be similar to those of a dormitory. Similarly, if an I-O study delves into the details of the expenditure profile made by a given institution, they will provide institution-unique findings.

B3.2.3 Utility

I-O studies are popular because they are relatively simple to conduct, they reflect the reality that expenditures by universities and colleges are tremendously important to the local economy, and they are often influential with policy-makers and politicians. This influence, however, runs both ways: I-O studies can be used to convince politicians that a given institution or initiative is worthwhile and used in turn by the politicians to convince the public of the same.

In the experience of the authors, some of this influence results because the multiplier effect is virtually always greater than 1.0 so long as most goods and services are obtained within the local region, and this is almost universally misinterpreted to mean the institution or initiative has "made a profit" (or will make one, in the case of planned initiatives). This is not, unfortunately, the case; it only means that most expenditures and re-expenditures are made locally (though see "value-add" below).

- In fact, a given postsecondary institution could graduate exactly zero HQP, its faculty could publish exactly ***zero*** papers, and its industry liaison office could license exactly ***zero*** innovations, and its I-O impacts would be ***exactly the same*** as a highly successful institution, so long as both had the same spending profiles.
- Further note that any operation with the same spending profile will generate the same "I-O impacts"; e.g., the civic government could mandate that every home in Toronto be painted purple. If this resulted in the same costs and spending profile as running GTA universities, the "I-O impacts" would be identical (ignoring any value added I-O methods).

This methodology has, however, become deeply ingrained in the psyches of postsecondary institutions, and it is very common elsewhere as well (e.g., for major capital projects and special events such as the Olympics). Thus it will take immense political will to foster alternative – or at least additional – approaches to this kind of EIA.

B3.2.4 Value-add techniques

Some I-O studies go beyond this basic approach to model important initiatives undertaken or about to be undertaken by the institution. Especially important here are initiatives that can be expected to bring external investment to the local economy. Examples include hosting large conferences and symposia, constructing conference and hotel centres to host those events, and building "Big Science" facilities that are

[14] Each province's statistical analysis unit publishes annual tables of standard multipliers, divided according to industry classifications, along with explanations of their applicability and use.

expected to employ large numbers of additional scientists and staff and attract external scientific teams to the region as visitors.

Here the analyst must often model the expected success of the initiatives in achieving their goals (including their ability to create direct, indirect and induced impacts) and the likely ramp-up of impacts over time. Therefore these value-add I-O studies go some degree down the road of investigating (or at modeling) downstream impacts, and some of these true value-added impacts in that funding from non-Canadian sources is brought to the region. These studies can also be quite informative and compelling, and may point out specific features of the initiative that could maximize its impacts, as when different scenarios are modeled. However, when used to justify future plans the reader may find that the results are strongly affected by the lobbying position of the authors. (Few such analyses seem to conclude that the proposed initiative is not worth doing.)

B3.2.5 Economic impact analysis (EIA)

EIA is a somewhat generic term for a variety of impact assessment techniques that take into account very similar factors as I-O analysis; i.e., the direct, indirect and induced impacts of a specific plan or initiative, in the forms of changes to factors such as revenues and/or profits, job creation and/or maintenance, wages and salaries, and perhaps taxes. One of the most commonly used EIA techniques is, in fact, I-O modeling. Additional techniques such as general equilibrium or econometric modeling are available to estimate the impacts of future economic or demographic changes. However, these are quite difficult to conduct, far more difficult to understand and quite challenging to employ at small scales.

B4. Impacts from training highly qualified personnel (HQP)

B4.1 Near- and mid-term impacts

Impacts and metrics. HQP are rightly considered one of the most important outputs of universities and colleges, but their true “downstream” economic impact for society is very difficult to judge. The simplest method is to estimate near-term and mid-term effects:

- Near-term – Metrics include the monies that HQP expend during their university or college tenure, for example on tuition, room and board, textbooks, specialized courses, general living and entertainment expenses, etc. Often a distinction is made between Canadian and foreign HQP, as the bulk of financial support for the latter usually comes from abroad. These expenditures can be used in two different ways, depending on the intent of the study:
  - As a measure of the direct and indirect financial impacts of the students in contributing to the local economy; i.e., as a portion of the I-O output modeling[15]; or
  - As a measure of the cost to HQP of obtaining the postsecondary training, in which case these costs (possibly supplemented by an estimate of wages and salaries foregone by taking this training instead

[15] And since some of this student spending represents money from foreign sources, it is not simply Canadian taxpayer money being re-circulated in the local economy. This might be quite properly thought of as one type of PSE success.

of having a "regular job") would be used in the cost side of the ledger when estimating the return on investment obtained by these graduates (see next point).

- Mid-term – The average wage/salary increment obtained by graduates compared to non-graduates and adjusting for the proportion of graduates who remain in the local economy. This can be estimated through:
  - Surveys of graduates and/or employers (better for learning the specific impacts of individual institutions or specialized training initiatives) – but note that this requires some method for tracking and contacting alumni, and extrapolating from a sample, or
  - By reference to average factors from the literature on these effects, by far the most common technique.

The net return for an individual graduate can then be calculated by estimating the total lifetime wage/salary increment gained by them[16] as compared to their average individual training costs as discussed under "near-term." Or, summed over all HQP that an institution graduates, the net return for all that institution's HQP can be estimated.

The effect on the HQP wages and salaries is well worth knowing – and in particular, if one finds that graduates do not earn a significant increment in lifetime earnings, one could conclude that something is seriously awry. However, it is a lower bound of the impact of training both for the HQP and for their employers and society. Other more subtle effects can also be modeled, such as:

- The incremental wage/salary effect can be used to model the increased taxes that the regional, provincial and federal governments will obtain. (Again, this is often done on a lifetime basis, if only because the number is far more impressive.)
  - Note, however, that these tax effects are nested within the incremental income (i.e., 'from one pocket to another") – they should not be added to it. Thus an incremental $100 earned may create an additional $25 in tax revenues, but the total impact is not $125.
  - In practice, the reader should be aware that many reports add the two together, or do so implicitly in the way the numbers are presented.
- Further impacts are not infrequently modeled (especially by colleges) in terms of the reduced likelihood that these HQP will suffer significant societal problems, such as finding themselves unemployed or suffering serious life style-related illnesses or disease, or involved with the justice system, all of which cause a drain on the public purse. While important societal effects, they are obviously more difficult to model, and attribution to the PSE system can be difficult to demonstrate.
  - Evaluators often call these "spill-over" effects as they were not the primary intended result of (in this case) education, while economists call them "externalities" as their benefits (and their costs, in

[16] Modeling this effect can be based on Statistics Canada data on average incomes by different education levels. It is not a trivial calculation, however, as it depends on how many credits each individual HQP obtained, and incomes tend to gradually rise and then fall over the individual's lifetime, with this curve also varying by education level. Adjustments may also be made for factors such as the relative mix of employment that graduates obtain (e.g., it may lean towards more knowledge-intensive, higher-paying jobs), the size of knowledge-intensive industries in the region, alternate education opportunities from other institutions or regions, the estimated proportion of HQP remaining in the area after graduation, and opportunities for employers to hire graduates of other institutions if the institution under study were not producing HQP. Ideally these costs and income effects over time will be discounted (see section 4.4.5). Not all studies will go to such lengths.

the case of negative impacts) are external to the organizations or individuals that have created them.

Methodologies. These metrics are estimated most easily by reference to published studies on average effects per HQP, for example from Statistics Canada data, supplemented by any additional analyses required (such as for effects on tax revenues). Of course, these will not assess the individual contribution of a specific postsecondary institution, and some organizations attempt surveys of their current students and/or alumni.

Incrementality and attribution. A significant issue in the analyses of both future earning potential and reduced societal costs is that the HQP are self-selected: they are not likely to be representative of the population as a whole. Thus these effects may be related to the characteristics of individuals who enter colleges and universities rather than to impacts of the education and diplomas themselves. An evaluation of the true incremental impact of PSE participation would be quite challenging to say the least, as one would have to find a control/comparison group of equally talented and ambitious individuals who did not obtain postsecondary training but for reasons unrelated to their personal characteristics. As a result, these analyses can best be thought of as a type of comparative modeling rather than rigorous analysis of value-added by postsecondary institutions.

B4.2 Longer-term impacts

Impacts and metrics. HQP do more than earn more money for themselves; they spend more in the local economy and pay more taxes. On the economic front, they also contribute the latest knowledge and expertise to their employers, whether in the private, government or not-for-profit sectors. The most entrepreneurial of them will found their own start-ups, many based in the high tech sectors, and if successful will contribute even more revenues, taxes and jobs. Any or all of these effects are important metrics to measure.

Methodologies. Identifying, tracking and estimating such impacts is of course more time- and resource-intensive, but an excellent way to distinguish one institution from another. For example, one that provides innovative entrepreneurship programs and/or degrees may find more impacts related to start-ups and spin-offs, while one that specializes in tailoring its curricula to the needs of local industry and government will likely find more benefits for the employers of these HQP. There is no “one size fits all” methodology to investigate such impacts, but options include:

- **Medium effort** – Conduct case studies of HQP associated with units within the institution (e.g., major R&D laboratories) that are known to have successful, long-term relationships with external users in industry and/or government. The heads of these units can often provide examples of important impacts of specific HQP individuals for specific employers and can arrange to contact them.
  - Case studies, of course, are not useful to sum up the total impacts of HQP, and if selected in this “cherry picking” way cannot be extrapolated to a total institutional impact. However, they provide very striking and concrete examples of impacts, some of which might be further pursued in benefit-cost analysis.
  - They also provide institution-specific findings and can be used to highlight important strategic initiatives.

- **High effort** – Conduct a follow-up study of alumni and/or their employers, investigating the specific contribution of individual graduates to their employers and (possibly) society more generally. Both economic and other factors can be investigated. The University of Alberta, for example, recently investigated a wide variety of impacts for their alumni, including:
  - Innovation and entrepreneurship: Organizations created; employment in those organizations; revenues created in those organizations; revenue/provincial GDP; revenue/employee; organizations created per founder; and patents; and
  - Measures of the most important experiences: Innovations (ever) of alumni over time (before, during, after, intended, ever); peer-reviewed papers; new process, product, services, business models; and design (educational, literary, artistic creation).

  A variant to this follow-up approach is to contact only alumni who are known to have formed their own start-ups. Various techniques can be applied but all rely on having a method of tracking alumni, contacting them, and surveying or interviewing them and/or their employers.
  - Various privacy concerns may hinder these efforts, but institutions can optimize results if alumni have the right to not participate without penalty and anonymity of individual results is assured.
  - Because of the likely low response rate, the ability to extrapolate from respondents' data may be limited but the results will provide a lower bound of actual impacts.
  - Such methods will provide institution-specific findings, highlighting specific strengths of the institution both in educating HQP and in supporting local innovation initiatives.

The results of such follow-up efforts can be striking, as seen in a recent study by MIT that estimated that the total active companies founded by MIT alumni employed 3.3 million people and had revenues of roughly $2 trillion, the equivalent of the 11th-largest economy in the world.[17] .Of course, one must question what portion of these figures is due to the education provided by MIT (as opposed to other non-PSE factors, such as the region's industrial cluster strengths) and what incremental value MIT provided over what other similar institutions could have provided, but the findings still show the potential power of such methods.

A University of Alberta survey[18] resulted in a scaled estimate that University of Alberta alumni have founded 70,258 active organizations with a combined annual revenue of $348.5 billion. These organizations are credited with creating an estimated 1,581,923 jobs globally, including 390,221 in Alberta. The average scaled revenue per employee for these organizations is approximately $220,000. Of the organizations created, one-third are estimated to have primarily a cultural, environmental or social mission, of which slightly more than 50% are estimated to be non-profit. The data on the staging of innovation and entrepreneurial activities suggest that the university is a catalyst rather than vessel or incubator of innovation and entrepreneurship. Alumni are more likely to engage in innovation and entrepreneurship once they have finished their degree programs rather than engaging in them during their programs.

[17] Edward B. Roberts and Charles Eesley. February 2009. *Entrepreneurial Impact: The Role of MIT.* Massachusetts Institute of Technology Sloan School of Management. Similar techniques have recently been employed by Iowa State University, Tsinghua University, and Stanford University.

[18] The University of Alberta survey of 84,387 (of 246,000) alumni yielded a response rate of 15% and a 10.5% rate (of all surveyed) of fully completed surveys – comparable to other international initiatives of this type.

Incrementality and attribution. As a final note, such follow-up studies also suffer from some lack of rigour regarding HQP self-selection, but at least one can postulate a significant link to the technical training received, and so the value-add by PSE training is clearer.

B5. Downstream impacts from using research findings and expertise

B5.1 Introduction

This is an area in which different institutions often make very distinctive contributions, as the nature and magnitude of impacts depend strongly on the R&D success of its researchers, coupled to strategic initiatives of both researchers and the institution to develop strong links to, and active partnerships with, external end-users. Unfortunately, this is among the most difficult category of economic impacts to identify, track and quantify, as it involves downstream impacts arising from long-term impacts on industry, government and society. At the time the research is done, these impacts may be completely unknown and thus impossible to describe, much less quantify. Further complicating the matter is that there are both direct and indirect routes through which impacts arise. We briefly discuss some of these routes here in the hopes they will trigger ideas as to how to identify and track them:

- **Private sector – Direct routes.** The easiest benefits to identify and measure will arise through direct routes, especially from traditional technology transfer (patenting, licensing and so forth), and most institutions track these closely. These benefits may be:
  - Unplanned ones arising unexpectedly from discovery research, in which case attribution to the institution licensing the technology may be somewhat difficult (it is likely that many other researchers at other institutions had some role in the discovery); or
  - Planned outcomes of strategic research, applied R&D programs, contract research, participation in industrial consortia, etc., in which case attribution to a single institution is usually easier.
- **Private sector – Indirect (non-traditional) routes**. More challenging to identify are impacts arising from indirect routes, even within applied industrial settings. These include creation of new value chains, improvements to the internal R&D capability of external partner organizations simply by participating in joint R&D projects, new policies and professional practices, better decision-making, changes to corporate business strategies, new partnerships and value chains, human resource development and more effective use of "big data."
  - For example, projects in which the sustainability of Canada's firms and industrials sectors, even if they have not resulted in new products and processes (e.g., they do not arise through patenting, creation of spin-offs, etc.) would be legitimate and important impacts to investigate.
- **R&D that affects entire industries** (often through open source IP developed over decades of effort and long-term partnerships between researchers and end-users) frequently have far higher net benefits than R&D that targets individual innovations for individual partner firms.[19]

[19] The authors have between them conducted over 40 economic impact and benefit-cost studies of R&D programs, and the highest impacts for Canada by far have *not* arisen from traditional technology transfer.

  - Many such non-traditional impacts can, with some thought, be defensibly quantified in dollar terms. The main challenge is often simply to identify these impacts. Many institutions are well versed in the importance of counting simple industrial metrics such as patents, spin-offs and license revenue, but put little or no effort into systematically identifying these more subtle effects, even though the importance of the latter may be much higher.
  - Also of considerable interest is that few of the transformative changes to society and industry have resulted from a single discovery. Even if one research project provided the seed, significant disruptive changes result from a long time series of incremental advances, often beginning with "ultra high tech" advances which, over time, eventually become commoditized. These are far more easily investigated through case studies that assess the impacts of entire programs of work, often conducted over decades. Of special note is that such transformative events will never be picked up through metrics related to traditional technology transfer (or impacts on individual firms), much less through "internal" metrics such as patenting and licensing revenues for the institutions.
- **Larger societal – Diverse routes.** Probably the most challenging of all to identify are the larger societal impacts of research, including public good impacts on community sustainability and well-being, individual and public health, and the environment:
  - While often difficult to attribute to specific activities, among the health impacts that would be important to explore are cost reduction in the delivery of existing services, qualitative improvements in the process of service delivery and increased effectiveness of services (e.g. health outcomes from improved prevention, diagnosis and treatment).
  - Impacts on individual behaviour, e.g. influencing gambling behaviours and reducing the incidence of problem gambling.
  - Impacts on policy decisions – whether through directly informing the formulation of a policy or through indirect influence through impact on the public media.
  - Improvements in professional practice, e.g. law, social work, education, business.
  - Improved decision-making and organizational processes.
  - Social innovations, including those that move individual communities more towards the knowledge economy.

B5.2 Impacts and metrics

The main impacts of interest are improvements to Canadian society and industry. On the industrial side, the metrics are normally reasonably easy to specify as they ultimately relate to sales revenue, profit and/or cost savings. However, there are often intermediary metrics of interest such as greater market share, development of new products and processes, an improved regulatory environment, better professional codes and standards, expansion of the work force, a stronger value chain, new R&D linkages, etc., some of which may be easier to measure (if often more qualitative in nature).

On the societal front, the impacts – and their corresponding metrics – are considerably more diverse and difficult to define but generally fall into two classes: (1) changes in levels of understanding, knowledge, attitude and behaviour and (2) changes in policy and practice. Such influences can result in effects such as stronger and more resilient communities in the face of social and economic stressors; a more knowledge-based population that makes better decisions; lower rates for crime, recidivism, unemployment and social welfare; fairer, more egalitarian and more ethical treatment of all citizens; lower rates of child and spousal abuse; lower incidence of racial tensions and prejudicial behavior; higher levels of individual and community happiness, satisfaction and contentment; more personal freedom and flexibility; more effective and equitable legal practice (e.g., through alternative dispute resolution processes); greater contributions of individuals to society as a whole; better interpersonal relationships; improved education; etc.

B5.3 The unit of analysis

In attempting to identify and measure these impacts, it is useful to consider first what unit of analysis should be used. Many studies attempt to start with “the research project(s)”, “the research initiative” or “the institution” as the unit of analysis. While this approach often works, it can be troublesome if multiple research projects in a wide variety of disciplines led to an important impact, or if multiple institutions (possibly including some non-PSE organizations) were involved. The study team has found that making “the impact” the unit of analysis is frequently more useful, as it is then easier to identify the manifold routes and possible non-linear factors that led to it.

Another factor often obscured in these analyses is exactly where the economic impacts occur. It is not uncommon to read studies that describe all start-up firms, all revenues and all job creation impacts associated with a given S&T initiative or university, and only notice in the fine print that most or all of these impacts occurred outside Canada. While useful to human society in general, these effects are rarely of great interest to Canadian taxpayers or governments.

B5.4 Top-down and bottom-up methodologies

Top-down methods generally focus exclusively on improvements to industrial productivity, rather than investigating other types of societal impacts such as for health care or the environment. Methods include general equilibrium models, total factor productivity estimates, and impacts on Gross Domestic Product (GDP) or Gross Value Added (GVA). All of these are more easily applied to R&D conducted at very large (e.g., national) scales. However, they are sometimes adapted for institutional-scale projects by using average factors from the literature.

Top-down methods are typically relatively simple to employ, as they estimate impacts by applying some average improvement factor derived from other studies; i.e., no original research need be done. The disadvantage of top-down methods is that same reliance on average values (sometimes derived from very large aggregates of institutions), and so impacts attributable to any given individual institution and its unique blend of products and services cannot be identified or quantified. Further, such methods are virtually impossible for non-economists (not to mention many economists) to understand, and the final estimates tend to vary widely by study.

Bottom-up methods start at a much smaller scale, from individual R&D projects to the outputs of significant laboratories and targeted research initiatives. In general they focus on what are colloquially termed “big winners.”

These methods are conceptually simpler to understand as they rely on detailed investigation of specific instances of impacts arising from R&D, whether it be from traditional technology transfer that applies the results of the research (e.g., patenting, licensing, formation of spin-off and start-up companies), or through more indirect routes that create impacts for external research partners (e.g., more internal expertise, changes in strategy, access to HQP, formation of new partnerships and supply chains), or from "knock-on" impacts in entirely different fields (e.g., remote sensing algorithms used for real estate market modelling[20]).

Bottom-up approaches also have the distinct advantage of identifying and (where possible) quantifying specific impacts attributable to the unique programming, activities and outputs of individual institutions. In this, they are far superior to top-down approaches, though usually requiring significantly more time, resources and effort. Unfortunately, there is a tendency to discount these as anecdotal unless they are framed in the context of a larger and more rigorous benefit-cost study.

B5.5 Top-down: Total factor productivity (TFP) methodologies

The major share of change to national GDP over time is usually due to changes to traditional inputs such as population growth, and therefore growth in the number of people in the workforce and the capital available to productive organizations. However, some portion of the growth is assumed to result from R&D done in the postsecondary, private and public sectors that increases the knowledge and innovation of firms and workers.

> *Over the past 20 years economic research has developed important new insights into economic growth through what is referred to as "new growth theory" (e.g. Romer 1994). New growth theory is based first on the long-standing observation that economic growth cannot be fully explained by a model based only on traditionally measured inputs: labour and capital of various types. Clearly something else is at work driving ever increasing levels of economic output. New models of economic growth demonstrate that the stock of knowledge measured in various ways is also a major determinant of economic growth. James Adams (1990), in a seminal study of growth, uses data on the quantity of published knowledge to explain economic growth. Though crude, the evidence is clear that knowledge production demonstrated through scientific publications is correlated with growth.*
>
> *The Economic Impact of the University of British Columbia*[21]

The portion of GDP increase owing to R&D is assumed due to improvements to total factor productivity (TFP) and has been estimated by various authors; e.g., Fernand Martin estimated that the portion of Canada's GDP growth resulting from increases to Canadian TFP is about 20%.[22]

One may then apply this 20% factor to any GDP increase seen for the local region that is under study and assume this portion of the GDP change is due to TFP changes. Three adjustments are made:

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[20] This is an actual example from a firm involved in Canadian space programs.

[21] Sudmant, W. (2009). *The Economic Impact of the University of British Columbia*. Retrieved from http://president.ubc.ca/files/2010/04/economic_impact_2009.pdf

[22] This approach has been also used, *inter alia,* by the University of Ottawa, the University of British Columbia, Simon Fraser University, the University of Alberta, the University of Calgary and the University of Victoria in their calculations of economic impact.

- Since a portion of R&D takes place outside the local region but is taken up locally, a correction factor of 69% for Canadian-based R&D (as estimated by Martin) is applied;
- Since some portion of the R&D is not PSE-based, another correction factor is applied based on Statistics Canada data on PSE-based R&D (PSERD) vs. business expenditures on R&D (BERD); and
- Since only a portion of PSERD within a given province is due to the institution under review, a third correction factor is applied based on the institution's total research funding as a percentage of total provincial HERD.

Such calculations are dependent on the assumptions used in the original TFP estimates and obviously do not distinguish among different postsecondary institutions – two institutions with the same R&D revenues will be assumed to have the same proportional causative effect on increases to local GDP.[23]

B5.6 Bottom-up: Case study methodologies

The conduct of case studies is well known and we will not belabour it. In short, they usually involve review of key documents related to the progress, outputs and outcomes of the case under review, plus interviews with key internal participants and external end-users. More interesting is how to choose them, which is often the key factor that dictates their use and utility.

- An external evaluator might well choose cases that exemplify both great successes and notable failures, in the hopes of identifying lessons learned that will help the institution and government funders have more of the former and fewer of the latter.[24]
- Institutions usually choose to report case studies ("success stories", "nuggets", etc.) that illustrate excellent progress in research and/or translation. Of interest is that these both provide a human face to research that is often very abstract but can form the basis for more sophisticate economic analyses at a later date. The institution's communications officers are often excellent sources for ideas on important economic benefits to investigate.

Case studies can be as simple or complex as desired and required. The two most complex case-study-based approaches known to us are (1) the CFI's Outcome Measurement Studies (OMS) approach[25], and (2) the TRACES and HINDSIGHT studies.

CFI's Outcome Measurement Studies. These assess the key impacts of major strategic investments made by individual institutions, using a complex case study approach.[26] The OMS does not focus exclusively on innovation and economic impacts, but it is one of the five important pillars studied. The four other pillars considered are strategic research planning, research capacity (which includes attraction and retention of top scientists), HQP, and research productivity. OMS has proven to be a powerful tool to uncover some

[23] It is unclear how to apply TFP methods if local GDP decreases instead of increases over time.

[24] Individual institutions might well do the same, strictly for internal review and strategic purposes, although to our knowledge this is rare.

[25] http://www.innovation.ca/en/AboutUs/Evaluation/OutcomeMeasurementStudyOMS

[26] Unusually for case studies, in addition to typical document review and individual interviews, OMS also employs site visits by an expert panel composed of individuals knowledgeable about both the scientific and the application/translation/technology components.

important impacts that were even unknown to the institutions themselves and has led some institutions to modify their strategic planning and organizational structure to best exploit those opportunities. Of importance here is that OMS case studies can be used as input to more explicit benefit-cost analysis such as described below.

TRACES and HINDSIGHT. These were retrospective studies[27,28] that investigated significant industrial innovations, tracking them backwards in time to the various discovery, strategic and applied research programs and projects that led to them. These fascinating but resource-intensive studies found that the gap between technical innovation and the research that supported it tended to range from about 10 years when speaking of "mission-oriented [applied] research" to 20-30 years for "non-mission-oriented [pure] research." These are of considerable theoretical interest and provided significant support for the need for a long-term portfolio of basic and applied research, as well as the importance of a long time series of incremental advances. However, they are not easily adaptable to short-term pressures to measure institutional impacts.

B5.7 Bottom-up: Partial benefit-cost analysis (PBCA) methodology

This method estimates a lower bound for the economic impacts from R&D. In PBCA, one carries out rigorous benefit-cost analyses through case studies of a sample of the highest impact projects ("big winners") and compares the net benefits of this sample to the total cost of a program. The "big winner" case studies investigated are those:

- with the highest known impacts – here is where the Communications Department and/or a "stretch" performance measurement system can be of great assistance (see section 4.8);
- having impacts that can be quantified in dollar terms; and
- where the impacts are clearly attributable at least in large part to the institution under review (as opposed to other parties).

Existing impacts of the "big winner" projects (only) to the time of the analysis are quantified, while future impacts are modelled over time using reasonable assumptions (usually based on detailed interviews). Any known costs to further develop, refine, produce or implement the innovation are netted out from the benefits stream. The analyst then sums these net benefits across all case studies and compares the sum to the *total* programming costs (i.e., of all projects and initiatives run by the institution, not just the small number of "big winner" projects under investigation[29]). The PBCA then calculates:

- Net Present Value (NPV) = (Net benefits of "big winner" projects) minus (Total programing costs[30]); and
- Benefit/Cost ratio (B/C) = (Net benefits of "big winner" projects) divided by (Total programming costs).

[27] Illinois Institute of Technology Research Institute, 1968. *Technology in Retrospect and Critical Events in Science*, Prepared for the National Science Foundation.

[28] Office of the Director of Defense Research and Engineering, 1969. *Project Hindsight,* Department of Defense (US), DTIC report no. AD495905. Washington, D.C.

[29] To our knowledge PBCA has never been applied at a whole-institution level, although it has been applied at other large scales, including for major research centres and major programs of the granting councils. Most likely only the direct and indirect R&D costs within the institution would be included, not costs of teaching.

[30] Including costs to external partners; e.g., for research partnership projects, major collaborative initiatives.

- Both the benefit and cost streams are discounted to compare the results to the next best use of the funding.[31]
- It is common to model several scenarios; e.g., more conservative lower bounds vs. more optimistic upper bounds.

Both the NPV and B/C figures provide very strong and defensible evidence regarding economic impacts, since the data and assumptions used for modeling each "big winner" are reported in detail.[32] Further, the NPV and B/C ratio are lower bounds: only a small number of "big winners" are investigated, and even for those only impacts that can be defensibly quantified in dollar terms are estimated, but the total net benefits are compared to the *total* programming costs.

PBCA has some advantages over other benefit-cost approaches. First, it can be used to study the impacts of long-term programs of R&D, since the unit of analysis is "the impact" not "the research project." Thus the cumulative impact of dozens or hundreds of individual research projects and contracts can be investigated without needing to identify the typically very modest incremental impact of each one – of interest is only the total impact summed over all projects and the entire timespan. A useful example in the agricultural R&D field is KPMG (2013[33]).[34]

PBCA is also very flexible, not being conceptually restricted to investigating or quantifying industrial benefits and not restricted to only investigating the most obvious impacts. All types of benefits, including those arising from both traditional and non-traditional and non-linear routes, are potentially "on the table." Our study team's PBCA investigations have found many instances of unexpected – but very significant – impacts arising in entirely unpredictable ways from both basic and applied R&D, but that would only have been uncovered through a *"follow your nose"* case study approach.

On the downside, PBCA is time- and resource-intensive, and neither the analyst nor the program under study can be certain of its success until deep into the project – there are simply too many unknowns when the project begins, especially as some of the most important impacts may be yet unknown. Further, it tends to be a difficult technique to understand fully amongst program, institutional and government decision-makers. Government organizations in particular are often more used to and comfortable with methods that depend on sampling and extrapolation. Thus more simplistic approaches – even if less ultimately revealing – may be preferred unless considerable effort is put into explaining PBCA.

[31] In practice discounting increases the value of any benefits and costs that occurred in the past and decreases the value of those that will occur in the future. Thus a project only providing benefits 10-20 years from now is usually not worth considering. (The crystal ball usually does not work so well so far into the future either!)

[32] Usually, each individual case requires a different, customized methodology for data collection, quantification and time series modeling. These are reported in enough detail for comprehension by lay readers and quality control review by experts in each field.

[33] KPMG LLP, May 15, 2013.*Evaluation of the Strategic Research Program (SRP) and Agriculture Development Fund (ADF) Final Report*.

[34] Two agricultural and agri-food R&D programs in Saskatchewan involved basic and applied research in topics such as seed genomics, soil quality, crop rotation schedules, pesticide and herbicide use, and seeding and tilling techniques. Over the course of 25 years these led to a 40% increase in arable soil being used in the province, along with increases to a number of crop revenues. The details of each individual innovation did not have to be studied, only the final outcome, although the analysis was highly complex.

B5.8 Bottom-up: Patent analysis methodology

A bottom-up tracking of patents through filing, licensing and exercising of patent licenses by an institution is one of the more ubiquitous forms of impact analysis deployed by postsecondary institutions. Most institutions report patent statistics in the context of a larger set of technology transfer data reflective of the fact that invention and innovation are different. While a patent is an output (one of several possible indicators of invention), a license exercised by a firm is an outcome and as such closer to what is really important – innovation and impact – albeit licensing is still a process indicator. The use of standard definitions documented by the Association of University Technology Managers (AUTM) provides a reasonably high degree of confidence in the comparability of such statistics among institutions.

Perhaps a more interesting approach to impact analysis is a top-down approach employing patents is the analogy of a TRACES or HINDSIGHT study in which there is a study of industry patents and their citations of postsecondary institution publications as an indicator of the origins of academic impact. However, this approach suffers from the same challenges as TRACES and HINDSIGHT discussed earlier.

In a related area, there has been investment in an integrated database that can trace the links from government investment in R&D through the path of knowledge creation, its transmission (including through patents) and codification, and ultimately in many cases to commercial uses. This is the COMETS (Connecting Outcome Measures in Entrepreneurship Technology and Science) database that has been supported by the US-based Kauffman Foundation. The study team is not aware of any comparable activity in Canada.

B6. Impacts related to cluster development

B6.1 Introduction

Postsecondary institutions can have significant effects on local clusters of expertise and/or industrial strength. These effects can include any of all of the impacts and metrics discussed above, in that one can assess them in terms of effects on local expenditures in a given type of cluster, or on HQP development, or on societal and/or industrial competitiveness. Further, there are many other factors that affect cluster development, including the transportation network, ITC strengths, regulatory and tax environments, access to risk capital and the like, within which the PSE environment is only one part. Thus the specific nature of metrics and methods related to cluster development varies perhaps even more widely than for any other, and because of the complexities involved in conducting such studies there is even less agreement on the best metrics and methods, and they are only occasionally attempted in rigorous fashion.

B6.2 Impacts and metrics

Having said the above, investigators have attributed part of the success of some clusters to the role played by leading postsecondary institutions such as Stanford in Silicon Valley, MIT, and the University of Waterloo in the ICT cluster in Southern Ontario. Drucker and Goldstein (2007) found that PSE activities can heavily influence the abilities of regions to attract and retain technology-intensive firms, provide the regional labour force with modern knowledge skills and provide the ability to respond flexibly to uncertain and rapidly changing economic circumstances. While non-PSE institution factors are often more influential than PSE factors, investigators have noted that the impacts of university activities on regional economic development, including cluster development, are considerable. These PSE contributions are quite varied, but a common theme is that they typically depend on two key things:

- long-term “two-way” relationships between faculty members and external partners; and
- expertise provided to the local economy by injecting HQP with the latest, greatest skills, as well as linkages back to top scientists.

Both of these can be considered as variants of *human capital development*.[35] Several studies have found that successful cluster development links back to the ability of firms to draw on the local knowledge base – the PSE role as a key source of R&D support and skilled HQP is the most important local asset that attracts firms to a region and retains them there.[36] Note that human capital development is an intermediary step in creating the cluster and fostering its ultimate long-term impacts. The ultimate impacts for industrial clusters would be as described in sections 4.3 and 4.4.

B6.3 Methodologies

No easy ways to map these effects at the individual institution level have been found to date, but both bottom-up and top-down methods have been attempted:

- **Bottom-up: Low effort** – Simpler methods usually rely on a review of industry-wide statistics on the growth (one hopes!) in the number of firms, jobs and GDP in the cluster, possibly supplemented by analysis of the industry’s structure (e.g., large multinationals vs. SMEs). Input-output analyses are often conducted within this framework as well.
  - Of course, these methods cannot investigate the incremental, attributable effect of postsecondary institutions as compared to other factors, much less that of one given institution, but at least they may demonstrate growth effects.
- **Bottom-up: Medium effort** – These studies couple simple statistical effects as in the Low effort options with investigation of local strategic and market factors that support or inhibit cluster development. These factors might be identified through literature review and research (including analyses conducted by Statistics Canada and think tanks such as the SSHRC-funded Innovations Systems Research Network) and/or through interviews or surveys with cluster firms.
  - Interviews and surveys afford some ability to assess “how” and “why” clusters succeed (or do not).
  - In particular, the relative importance of PSE strengths versus other factors can be investigated and ranked in importance, as can the relative importance and roles of individual institutions, their researchers, training programs, and industry liaison offices.
  - Survey efforts often suffer from low or very low response rates, with possible response bias being a problem as well.

[35] The study team notes that these effects have been strongly confirmed in various EIA and PBCA studies that the team has conducted.
[36] (e.g., Bramwell and Wolfe, 2008); Wolfe (2008); Druker and Goldstein (2007)

- **Bottom-up: High effort** – More complex studies have focused on measuring the downstream effects of PSE on wider conditions in the regional economy, geared to measure the more intangible and non-linear effects of PSE on the generation and sustainability of innovation performance.
  - Specifically, these studies were framed to capture indicators of increasing human capital through detailed case studies of the sector, or surveys of firms in the cluster and/or start-ups and HQP associated with the institution.
    - These studies are sometimes conducted at a single university level (e.g., see discussion of the OMS method in section 4.4.6) and very occasionally through a regional approach involving multiple institutions (e.g., focused on a specific industry sector rather than a specific institution). In the latter case, attempting to identify the specific contribution of an individual institution is usually impossible in a quantitative sense but may be well described qualitatively.
    - Case study and interview approaches often yield higher response rates and lower response bias.
  - **Top-down – Knowledge production functions –** Some studies link R&D expenditures to the production of information, typically corporate patents, along with analysis of the proximity and location of user firms, or relevance to small firms vs. large firms.
    - The main drawback is that not all knowledge is codified and the impacts of tacit knowledge and shared expertise generated through a postsecondary institution would be missed in this method. As many very important impacts occur through non-protected IP routes, this is a critical limitation.
    - It is, however, one approach to identifying a lower bound of an institution's impacts.
  - **Top-down** – Quasi-experimental designs. These analyze the empirical relationships between the input variables (e.g., S&T expenditures, publication rates, patenting, all by sector) and impact variables (e.g., GDP and job growth by sector), most often using regression-based statistical approaches. The appropriate dependent variables and measures of independent variables and control variables are suggested by the literature, the available data and the study context.
    - The primary advantage of the cross-sectional approach is flexibility. Its disadvantages include susceptibility to sampling issues and the very real possibility of omitting important input variables, especially if these are not captured in the institution's metrics.
    - And again, institution-specific impacts will be nearly impossible to determine, as will unexpected benefits that do not follow the average statistical model.

B.7. Impacts related to broader social benefits

B7.1 Introduction

Although this paper focuses on more traditional economic impact measurement as related to dollar-value impacts, we include a short discussion of broader societal benefits both for completeness and because these are intended to be one of the key long-term impacts of the PSE system. Some are potentially amenable to quantification as well. Recent work has attempted to identify, quantify and monetize the larger social impacts of PSE. Such approaches are in their formative stage but still merit attention.

If the reader thinks measuring direct economic impacts is tough, try measuring the broader social impacts! A well-recognized approach is that proposed by Sandra Nutley et al. that specifies two domains of social/cultural impact: (1) changes in levels of understanding, knowledge, attitude and behaviour; and (2) changes in practice and policy-making. However, there are few broadly adopted metrics and methodologies for evaluating such social benefits and impacts, let alone monetizing them. There is, however, an increasing amount of research directed towards this issue, if for no other reason that the recognition that "what is not measured is not valued." The result is considerable progress in articulating "process" metrics – indicators of activities deemed to be proxies for effective knowledge translation and uptake by users. These are roughly equivalent to the intermediate metrics used in technology and knowledge transfer in the national sciences – they are known to be important, but not sufficient, in generating ultimate impacts. The Payback methodologies and the Canadian Academy of Health Sciences (CAHS) approaches to impact measurement both employ such metrics. (See section 4.7.)

A useful example to illustrate the challenges in quantitative measurement of the impact of research in the two impact domains above is the work by the International Panel on Climate Change (IPCC). While founded primarily on scientific evidence, the actual work of the IPCC involves knowledge assessment and integration, coupled with a considerable amount of social sciences. The intent of the IPCC is to communicate knowledge and implications of that knowledge to decision-makers and to society at large, effectively addressing both of the above domains of impact. One can envision developing metrics that provide indirect insights on the extent to which public knowledge and attitudes have been altered and the extent of changes in policy and practice, but it is unlikely that even the most daring economist would attempt to monetize those changes possibly attributable to the IPCC work. Nonetheless, if those qualitative effects do not exist, it is unlikely that quantitative economic impacts will arise.[37]

Interestingly, it appears that the non-profit sector is further advanced than the PSE system in its pursuit of new approaches to quantifying returns on investment through the "Social Return on Investment" or SROI methodology.[38]

B7.2 Impacts and metrics

In the absence of a standard approach to impact measurement beyond I-O analyses, the more creative techniques involve the development and implementation of "process" metrics for capturing the likelihood of broader social impacts. Among the metrics that are advocated for use (but not necessarily frequently employed)[39] are the following:

[37] There has been a recent initiative to monetize the social impacts of social sciences research through a novel methodology developed for the London School of Economics by Cambridge Econometrics. In addition to a standard I-O approach, it attempts to place a value on the expertise provided by the academic community to external end-users, recognizing that SSH research rarely results in new products or protected IP. Although the study team has not seen other applications of this approach, it is similar to that often employed in PBCA for valuing the more indirect impacts of R&D activities for end-users.

[38] SROI Methodology: An Introduction. Retrieved from http://evpa.eu.com/wp-content/uploads/2010/09/SOCIAL-EVALUATOR-SROI-an-introduction.pdf

[39] For example in the work of CAHS, LSE and RAND.

Precursors to impacts on levels of understanding, knowledge, attitude and behaviour[40]

- Number of lectures given to public audiences
- Electronic or other records of the research discussed in general and social media
- Survey data on public attitudes
- Incidences of positive or negative behaviour (as was documented for ParticipAction)

Precursors to impacts on practice and policy-making[41]

- Number of consultations to policy makers (from organizational to national policy) by researchers
- Number of requests for research for policy makers; primarily systematic reviews
- Research mentions in publications (leaflets etc.) produced by advocacy groups, including patient organizations
- Number and type of citations to research in public policy documents (grey literature)
- Number of collaborations with end users

While some of these metrics may seem far from the point of impact, there is empirical evidence that the involvement of practitioners in the research and dissemination process enhances prospects for uptake of research, especially if initiated in the early stages of the research process.[42]

B7.3 Methodologies

In large measure, methodologies for assessing broader societal impacts mirror many features of methods such as PBCA, in that they first identify key stakeholders, map the intended outcomes (often using logic diagrams, and developing specific metrics and indicators for each type of outcome), investigate whether those outcomes actually occurred (and quantify and/or monetize them if possible), consider incrementality and attribution of the impacts, and establish a value for the total benefits minus costs. SROI methods follows this pattern.[43,44] Unlike simple benefit-cost or industrial EIA studies, the benefits in such studies are inclusive of all societal impacts; and like PBCA, users of SROI are encouraged to focus on only the most important outcomes and to attempt quantification of all important impacts.[45]

The SROI methodology employs two approaches to monetization, approaches that are independent of each other. Both or either can be used, according to the circumstance:

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[40] Some of these may lead to quantifiable dollar impacts.

[41] Intended to lead to quantitative cost savings and increased efficiencies, in addition to the qualitative impacts.

[42] Cousins, J. B., & Simon, M. (1996). 'The nature and impact of policy-induced partnerships between research and practice communities', *Educational Evaluation and Policy Analysis*, *18*(3), 199-218. The same effects have been found for research in the natural sciences, engineering and health. However, in all fields there is evidence that self-reported measures of integration of research into practice significantly overestimate actual behaviour.

[43] A guide to Social Return on Investment, 2012. Retrieved from http://www.thesroinetwork.org/publications/cat_view/29-the-sroi-guide.

[44] Assessing the Impacts of Academic Social Science Research: Modelling the economic impact on the UK economy of UK-based academic social science research, 2012. Retrieved from http://blogs.lse.ac.uk/impactofsocialsciences/files/2013/10/Impacts-of-academic-SSR-Cambridge-Econometrics-Nov-2012.pdf

[45] http://ccednet-rcdec.ca/en/evaluation-SROI

- The cost price-based approach is used where comparable (cost) prices are known for the indicator (e.g. an environmental factor). There are a number of relevant monetization methods from the large infrastructure projects that integrate consideration of the likely costs of restoration, environmental impacts, public health effects, etc. A disadvantage of this method is that it highlights the cost savings rather than the total creation of value (although an estimate of minimum value is obtained).
- The value-based approach that focuses on measuring the value that a change creates for all stakeholders for which no direct cost method is available – e.g. such impacts as cohesion, feeling, etc. The methodology involves determining the ascribed value of a situation change by asking the stakeholders about it (e.g., willingness to pay and/or willingness to accept). The downside of this approach is its subjectivity.

Given the interest among postsecondary institutions of demonstrating a breadth of economic impacts, SROI would appear to be a valuable addition to the impact analysis toolbox.

B.8. Recent methodological trends and specialized approaches

B8.1 Mixed approaches

Internationally, approaches to outcome/impact assessment in the past have relied heavily on qualitative analysis alone (e.g., from interviews, surveys, qualitative case studies). Recently, however, best practices often involve a *mixed* qualitative and quantitative approach. Mixed approaches provide the quantitative information essential for communicating impacts to policy-makers and government, while the qualitative information is essential for understanding how and why these impacts occurred and may be of even more interest to the institutions themselves for future strategic decisions. A recent selection of mixed approach adopters is:

- RAND – the Payback Methodology based on the work of Buxton and Martin at Brunel University in the UK[46]
- The CFI Outcomes Measurement Strategy (OMS)
- The Canadian Academy of Health Sciences (CAHS) framework[47]
- CIHR's performance measurement strategy

Although the metrics used in such approaches are normally not monetized, PBCA or PBCA-like techniques are sometimes employed within these studies under special circumstances.

All mixed approaches must be tailored to the specific organization and its strategic objectives, and in particular its specific intended outcomes and impacts. They do not use a "grab bag" of metrics but instead use a tightly focused set appropriate to the circumstances, and often employ case study methods that can investigate not just what the impacts are but exactly how they arose.

[46] http://jonathanstray.com/papers/PaybackFramework.pdf
[47] Canadian Academy of Health Sciences Assessment Report, January 2009. Report of the Panel on the Return on Investments in Health Research. *Making an Impact A Preferred Framework and Indicators to Measure Returns on Investment in Health Research.*

In particular, many important impacts arise from indirect effects discussed earlier and "behavioral additionality" (changes in the way organizations conduct R&D as a result of collaborations and interactions). Case studies are therefore a key supplement to the use of any performance indicators that may be in use.

B8.2 Health care and the payback framework

In the health care research field, the Payback Framework is a case study-based approach to measuring impacts further downstream than the simple conduct of research. Of importance is that the innovation program under study is first reviewed through development of a logic chart to identify possible types of impact and routes for achieving them (including indirect and non-linear routes). The five categories of Payback benefits are:

1. Knowledge;
2. Benefits to future research and research use;
3. Benefits from informing policy and product development;
4. Health and health sector benefits; and
5. Wider social and economic impacts (which include social or economic effects that change society, including impacts on public opinion).

Note that categories 3, 4 and 5 would be considered important downstream benefits and any or all of these might be considered within other measurement techniques such as PBCA. Both quantitative and qualitative impacts and methods are considered within each category, so this would be considered a mixed methodology.

The Buxton framework has been successfully used for a number of health research initiatives such as the Arthritis Research Campaign (ARC) in the UK[48]. This study was done on a case study basis and assessed the impacts of ARC in terms of use of research results to improve quality of life and the impact on improvements to live birth rates.[49] However, it did not attempt to quantify or value the reduction in sick days or sales of pharmaceuticals. It is noteworthy that this is a "state-of-the-art" methodology in the health sciences, and although compared to the physical sciences it seems [from our perspective only] to be in a relatively early stage of development, the ARC study has reportedly been influential in terms of garnering acceptance for the Buxton framework.[50]

B8.3 Bibliometrics and altmetrics

Bibliometric approaches are a major component of outcomes assessment, in particular to demonstrate prestige and to benchmark institutional performance against that of other institutions. They do not,

[48] Steven Wooding (RAND Europe), Stephen Hanney (Health Economics Research Group, Brunel University), Martin Buxton (Health Economics Research Group, Brunel University), and Jonathan Grant (RAND Europe). 2004. *The Returns from arthritis research.*
[49] Different arthritis pain medications and combinations thereof affect birth complications.
[50] Janet Halliwell, Executive VP – Social Sciences and Humanities Research Council of Canada, personal communication.

however, provide direct insight into economic impacts from PSE, although related approaches such as patent analysis are sometimes used. The latter provide a very narrow lens through which to view impacts, however, as many of the most important PSE impacts do not arise through protected intellectual property.

Another recent tack is to use "altmetrics." This is a variant of bibliometric analysis but attempts to identify both scientific and other outputs, including those in the social sciences and humanities (e.g., datasets, software), as to their interest to other researchers and potentially for broader non-scientific audiences. Altmetrics does not, however, actually follow up on what those external interests, end-users or end-uses might be.

B.9. Performance measurement (PM) systems

B9.1 Introduction

We discuss PM systems as they are often the first point of focus for institutions wishing to document their impacts. Performance measurement (PM) systems are usually intended for one or more of three main purposes:

- **Monitoring** – to help monitor the performance of the institution or individual initiatives in moving forward, for example against its mandate as negotiated with the provincial government and its most current Strategic Research Plan (SRP), as required by the CFI and Canada Research Chairs programs;
- **Demonstrating** – as part of the information required to explain to external audiences – especially government and other funding organizations – what the institution/initiative intends to accomplish and what those achievements actually are; and
- **Informing** – as input to help implement an individual institution's strategy and forward directions.

PM systems virtually always address the first two bullets above and are normally tied to a logic diagram that links the activities and outputs of an institution (or individual major initiative or program) against intended outcomes and impacts.

Regarding the reference to the institutional strategy in the last bullet, the PM framework can help with strategy development in two ways. First, the logic chart can point out gaps, inconsistencies and opportunities within the internal logic of the institution's activities/priorities. This can, in turn, help optimize the performance of the institution's corporate strategic actions, as these unexpected gaps and opportunities are addressed.

B9.2 Utility of "standard" PM systems

Organizations often attempt to use PM systems to capture important impacts on an ongoing basis, and they are sometimes seen as a panacea for all problems measurement-related. Although most PM systems capture important tombstone data for inputs and upstream impacts (e.g., number of grants, grant revenues obtained, HQP trained), most focus on metrics that are the easiest to understand and, of those, the easiest to measure. This usually means that many (or all) important downstream impacts are not captured.

Attempting to include all important metrics in a complex PM system usually generates significant resistance from the individuals providing the raw data, and the resulting information is then inaccurate and incomplete. In short, PM systems should not be overly relied upon for more complex data.

B9.3 "Stretch" PM systems

To address the shortcoming discussed immediately above, a "stretch" PM system can be designed that helps identify some key downstream benefits that can be pursued at a later date in more detailed, specialized studies such as PBCA, OMS or Payback. Remembering that one source of suggestions for "big winners" to pursue in such studies is the institution's communications unit, this is simply a way to feed information on such impacts into the system on a more routine basis. This results in the institution at a corporate level being aware of more of these impacts, and in a more timely fashion than the often piecemeal and accidental way that is common now.

Of course, the university's Industry Liaison Office (UILO) is already aware of some of the direct impacts that result in disclosures, patent applications and licensing, but even this information is usually the tip of the iceberg – the institution may know their own licensing, royalty and contract revenues, but have only a very incomplete picture of the impacts for the external end-users, especially those that have the larger societal, environmental and cultural impacts. Few institutions are keenly aware of the many important indirect and non-linear benefits arising from their activities, as these do not usually go through the UILO. (Often they only become known when the external partner nominates the lead researcher for recognition through means such as NSERC's Synergy Award.)

B9.4 Measurement is quantum

One final important point regarding PM systems: "measurement is quantum." Measurement changes the system – because PM systems implicitly reward researchers, teachers and staff for doing what the system asks them to measure, those are (quite naturally) the things they tend to focus on doing. This is either for the better or for the worse:

For the better:

- If the metrics are sensibly and logically aligned with the desired impacts, including long-term downstream impacts and those arising from indirect and non-linear routes, these metrics will then tend to encourage researchers and institutions to pursue all important routes for creating impacts.
- If measurement uncovers impacts unknown even to the participants, such measurement will affect institutional strategy in highly positive ways.

For the worse:

- If the metrics drive simple, short-term, self-serving "internal" impact, impacts for external end-users will get short shrift.

- If the metrics (or the implied nature of the underlying innovation system) ignore important impacts because they are defined in too limited a fashion, any impact that does not fit the exact definition will tend to be ignored.
- If important impacts are not understood to be – and explicitly discussed as being – important, or they are difficult to measure. This is a very common problem for indirect and non-linear impacts.
- Generally, everyone involved in research programs is very busy (often overwhelmed) and therefore takes the easiest tack when faced with reporting responsibilities. They provide exactly what is asked for, using the simplest possible interpretation, and nothing more. Thus being very clear about the importance of non-traditional technology transfer, for example, is beneficial. Also highly useful is having someone outside the direct research programs responsible for investigating these less obvious impacts and reporting on them.

Three simple examples are:

- If the key metrics are “creation of spin-offs”, “commercialization” and “industrial revenues”, institutions and researchers rarely think about innovations that are based on non-exclusive IP, or that result in cost savings, or that result in significant process (as opposed to product) innovations, or that result in critical societal impacts. Anything that does not result in commercialization of a new product is technically seen as a “failure” with respect to the metrics.
- If one’s metric is “HQP graduates”, then it is easy to miss the importance of tracking where these individuals go, what they do in their new positions, and what importance their knowledge has for their employers and for society, all of which can loop back to help inform decisions about the nature and quality of training these HQP receive.
- If one’s metric is “outreach to the community”, it is too easy to focus on how many outreach activities there are, or perhaps even how many community members attend or visit websites, rather than trying to understand the impacts that result from better public knowledge about important societal questions such as dealing with an aging population, or creating and using genetically modified organisms.

Appendix C – Summary of EIA Methods in Common Use by Postsecondary Institutions

Overview

The study team reviewed a number of Ontario, Canadian, and international EIA reports. While not pretending to be a statistically representative sample, we are confident that these demonstrate methodologies and metrics commonly in use, and in this section we summarize these methods by institution.

The summaries are provided in the tables that follow:

- **Table 1: Ontario**
- **Table 2: Other Canadian**
- **Table 3: The US** (Metrics shown in Table 3 are somewhat different from those in Tables 1 and 2 because of differences in approach)
- **Table 4: The UK** (This table also uses somewhat different metrics that those in Tables 1 and 2)

Acronyms used in the tables

B/C	= Benefit/cost
CRC	= Canada Research Chairs
CERC	= Canada Excellence Research Chairs
D	= Direct
ID'd	= Identified
FT	= Full time
FTE	= Full-time equivalents
GDP	= Gross Domestic Product
GVA	= Gross Value Added
I	= Indirect
Ind	= Induced
PSE	= Postsecondary education
PT	= Part time
Qual	= Qualitative
ROI	= Return on investment
WS-UBC	= Water Stewart study for UBC (this set of methods is commonly used by other institutions)

Interpretation of the tables

The most glaring feature of the tables below is the sheer variety of approaches, methodologies and specific metrics that are employed world-wide by postsecondary institutions. There are also significant challenges in comparing institutional approaches that employ differing terminology. There is clearly no magic bullet that is widely accepted by a majority of institutions.

The second obvious point is that methods and metrics are very frequently used to assess upstream impacts (this is something that virtually every institution does) but that those that assess downstream impacts are far less commonly used, even for traditional technology transfer. Even where relatively simple metrics that are precursors to TTT might be used (e.g., research contracts, patents, licenses, number of start-ups and spin-offs created), these are often not reported in EIA studies. Similarly, important "process" indicators such as long-term, two-way relationships (e.g., funded and externally solicited ones) between researchers and end users are not frequently reported. Where downstream impacts are assessed, generic methods that apply at a national level are far more frequently employed than institution-specific ones (quite likely because the former are so much easier to use). This neglect of downstream impacts is even more true where non-traditional technology transfer, or indirect routes, or societal benefits are involved. While a few more sophisticated, subtle and complex investigations have been identified (e.g., those assessing the institution’s impacts on the local innovation ecosystem), these are few and far between and many do not attempt serious quantification even so.

In short, most approaches are relatively simple but limited. No one has yet found an easy solution to obtaining a comprehensive, multidisciplinary, multi-sectoral and robust method for identifying and quantifying the true long-term economic impacts (industrial, health care and societal) associated with the main mandate of postsecondary institutions: research and teaching. This is not because such methodologies do not exist at all but most likely because: (1) they are more time- and resource-intensive; (2) funders have not required them; and (3) institutions have not recognized their power in helping explain their specific impacts to funders and the general public, and in helping the institutions refine and improve their internal strategic plans.

Table 1: Ontario Postsecondary Institutions

	U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
Methodology	WS – UBC	Custom	Qualitative/Quantitative	WS-UBC	Custom	
Source	Internal[51]	Internal[52]	Internal[53]	Internal[54]	External[55]	External[56]
Year of study	2012	2012	2009	2013	2013	2013

[51] **University of Ottawa.** Compiled from Díaz, V., Mercier, P., Duarte, S. (2012). *Economic Impact Study*. Retrieved fromhttp://www.uottawa.ca/services/irp/docs/ECONOMIC_FULL_REPORT_ENG.pdf

[52] **University of Guelph & OMAFRA.** Compiled from PWC (2012). *Ontario Ministry of Agriculture, Food and Rural Affairs/University of Guelph Partnership Agreement Economic Impact Study*. Retrieved from http://www.uoguelph.ca/omafra_partnership/research/en/innovationpartnerships/resources/OMAFRA_U_of_G_Economic_Impact_Study_FINAL_REPORT_Dec_10_12.pdf

[53] **Northern Ontario School of Medicine**. Compiled from Centre for Rural and Northern Health Research, Lakehead University and Laurentian University (2009). *Exploring the Socio-Economic Impact of the Northern Ontario School of Medicine.* Retrieved from https://www.nosm.ca/uploadedFiles/About_Us/Media_Room/Publications_and_Reports/FINAL_Report_(NOSM_Socioeconomic_Impact_Study-2009-11).pdf

[54] **University of Toronto**. Compiled from Office of Government, Institutional and Community Relations (2013). *University of Toronto Economic Impact Report.* Retrieved from http://universityrelations.utoronto.ca/gicr/files/2013/07/economic-impact-2013.pdf

[55] **University of Toronto Mississauga.** Compiled from KPMG LLP (2013). *University of Toronto Mississauga Economic Impact Report*. Retrieved from http://www.utm.utoronto.ca/about-us/economic-impact-report

[56] **University of Waterloo.** Compiled from (2013). *Economic Impact Study*. Retrieved from https://uwaterloo.ca/about/sites/ca.about/files/uploads/files/c003711_economic_impact_report_lr-oct24.pdf

			U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
Indicators and descriptors utilized								
Operations - baseline metrics								
	Institutional expenditures							
		Operations	X		X	X	X	
		Student aid						
		Capital				X	X	
		Capital depreciation amortization						
	Institutional employment							
		FTE and/or FT & PT				X	X	
		Salary & benefits/payroll	X		X	X	X	
		Employee benefits						
	Institutional income sources							
		Tuition			X			
		Federal grants and contracts (non-R&D)			X			

	U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
Provincial grants and contracts (non-R&D)						
Non-government income			X			
Research						
Other external to institution						
Alumni						
Affiliated institutions						
Extension/experimental stations						
Other (e.g., FIC[57] at SFU)						
Students						
Student numbers				X	X	X
Split by FT, PT	X				X	
By credential level	X				X	
Prov/State inflow of students (No.)						
Student spending				X		
Off-campus expenditures	X				X	
By credit students						
By students in continuing studies						
Students staying in province post-graduation						
Added employer income (a)[58]						
Part-time work – students						

[57] Fraser International College
[58] (a) = Added employer income ~= Student productivity effect

			U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
		Student placements, coop, internships						
	Employment							
		Employment status of graduates						
		Employment by occupational group						
	Diverse learning initiatives							
		Professional and high-demand offerings						
		Workforce training/work to learn				X	X	
		Non-credit offerings/students						
		Community-based learning /service learning					X	

	U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
Out-of-province and international students						
Number and % of PSE					X	X
GDP impact						X
Employment/FTE impact						
Income impact						
Tax revenue (and related)						
Graduate student prestige and impact					X	
Visitor spending						
Types of visitors		X				
Number		X				
Length of stay		X				
Spending per day		X				
Spending		X				
Economic indicators						
I-O overall – through direct expenditures						X
Overall $$/GDP impact			X		X	
As % of provincial GDP				X		
As % city/local region	X		X	X		
Jobs generated/FTE impact			X	X	X	
Collateral income from jobs elsewhere						
Tax revenue						
Incremental earnings						
Integrated investment value						
Net present value of benefits						

			U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
		Rate of return						
		Benefit-cost ratio						
		Payback period						
	I-O Institutional spending (including staff salaries)							
		Direct	X			X	X	
		Indirect	X			X	X	
		Induced					X	
	I-O Student spending							
		Direct	X			X	X	
		Indirect	X			X	X	
		Induced					X	
	I-O Visitor spending							
		Direct	X				X	
		Indirect	X				X	
		Induced					X	

			U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
	Education premium/incremental earnings						X	X
		By degree level	X					
		By field of study						
		Private benefit						
		Opportunity cost of education						
	Student productivity effect							
		Direct						
		Indirect						
		Induced						
		As % of province						
	Investment analysis (student)/private rate of return							
		Net present value of benefits						
		Rate of return/ROI						
		Benefit-cost ratio						
		Payback period						
	Investment analysis (society)/social savings							
		Net present value of benefits						
		Rate of return						
		Benefit-cost ratio						
		Payback period						
		Net present value of benefits						
		Rate of return						
		Benefit-cost ratio						
		Payback period						

	U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
Ecosystem impact of capital projects					X	X
Spending multiplier						
Institutional $$$						
Government $$$						
B/C Ratio						
Social B/C ratio						
Government Investment B/C ratio						
Internal rate of return						
R&D and innovation						
Financial flows						
Research funding				X	X	
Research funding from industry				X	X	
University R&D spending				X		
Indirect cost recoveries						
Income from licensing & royalties						
Value – equity portfolio						

	U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
Prestige indicators						
CRCs and CERCs				X	X	
Others				X	X	
Bibliometrics						
Volume (numbers of publications)						
Quality proxies						
National and international collaborations				X		
Technology transfer						
Patents filed incl. by country					X	
Licenses granted and executed				X	X	
Cumulative licenses						
Invention disclosures				X	X	
Industry contract work						
- Separate joint projects and consultancy						
Start-ups and spin-off firms/yr.					X	
Number				X		
By company name, sector and/or employment stats				X		
By type, differentiated				X		
Currently active, total						

			U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
	Research collaborations, civic engagement							X
	Incubated companies							
	Research impact							
		On GDP/GDP growth						
		Total factor productivity						
	R&D shares							
		Institution as % of provincial PSE R&D	X			X		
		PSE as % of provincial R&D	X			X		
	Productivity gains using methodology of F. Martin						X	
	Induced/dynamic rate of return							
	Research park							
	Specialized institutes						X	X
Diverse								
	Local indicators							
		Local content of expenditures	X				X	
		Location of employees residence	X					
		Impact on various regional population, employment stats					X	

	U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
Innovation & entrepreneurship						
Organizations created						
Employment in orgs created						
Revenues in orgs created						
Revenue, provincial GDP						
Revenue per employee						
Organizations created per founder						
Measure of most impactful experiences						
Entrepreneurial supports				X	X	
Innovations (ever) of alumni and time						
Peer-review paper						
New processes, products, services, business models						
Design, educational, literary, artistic creation						
Patents						
Tax revenue generated for government						
Income generated for government						
Economic impact of tax revenue						

			U. Ottawa	U. Guelph OMAFRA	Northern Ontario School of Medicine	U. Toronto	U. Toronto Mississauga	U. Waterloo
	Outreach and community engagement							X
Other								
	Sensitivity analysis							
	Comparison with others – benchmarking							
Contextual positioning								
	Profile by economic sector							
		Revenue						
		Jobs						
		Regional			X		X	
		Strategic focus			X		X	

Table 2: Other Canadian Postsecondary institutions
Alberta (E&I)* = Innovation and Entrepreneurship

	Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
Methodology	WS-UBC	Eesley et al	WS-UBC	Custom	Narrow	WS-UBC	WS-UBC	WS-UBC	Custom	Custom	Custom/ standard	I/O
Source	Internal[59]	Survey[60]	Internal[61]	External[62]	Internal[63]	Internal[64]	Internal[65]	Internal[66]	External[67]	External[68]	External[69]	Internal[70]
Year of study	2012	2013	2013	2003	2007	2012	2009	2012	2013	2009	2011	2002

[59] **University of Alberta.**· Compiled from Briggs, A., & Jennings, J. (2012). *The Economic Impact of the University of Alberta: A Comparative Approach*. Retrieved from http://people.ucalgary.ca/~icweb/flippable/Economic_Impact_Report/Economic_Impact_Report.pdf

[60] **University of Alberta.** Compiled from Briggs, A., & Jennings, J. (2013). *Uplifting the Whole People: The Impact of University of Alberta Alumni through Innovation and Entrepreneurship*. Retrieved from http://uofa.ualberta.ca/news-and-events/-/media/ualberta/news/ExpressNews/Images/Documents/AlumniImpactSurveyFullReport.pdf

[61] **University of Calgary.** ·Compiled from Office of Institutional Analysis (2013). *University of Calgary Economic Impact Report.* Retrieved from http://people.ucalgary.ca/~icweb/flippable/Economic_Impact_Report/Economic_Impact_Report.pdf

[62] **Alberta Colleges and Technical Institutes.** Compiled from Kjell, A. C., & Robison, M. H. (2003). *The Socio-economic Benefits Generated by 16 Community Colleges and Technical Institutes in Alberta*. Retrieved from http://www.macewan.ca/web/services/ims/client/upload/Seim%20Report%20Combined.pdf

[63] **British Columbia Institute of Technology**· (2007). Compiled from *The economic impact of the British Columbia Institute of Technology on British Columbia.* Retrieved from http://www.bcit.ca/files/about/pdf/bcit_economic_impact_2007.pdf

[64] **University of Victoria.** Compiled from Laliberté, V., & Eder, T. (2012). *The Economic Impact of the University of Victoria*. Retrieved from http://www.inst.uvic.ca/other/2012-UVic-Economic-Impact-Report-web.pdf

[65] **University of British Columbia.**· Compiled from Sudmant, W. (2009). *The Economic Impact of the University of British Columbia*. Retrieved from http://president.ubc.ca/files/2010/04/economic_impact_2009.pdf

[66] **Simon Fraser University.** Compiled from Sun, W., & Naquvi, Z. (2014). *The economic impact of Simon Fraser University.* Retrieved from http://www.sfu.ca/content/dam/sfu/irp/special_reports/Economic.Impact.2012.13.pdf

[67] **British Columbia Colleges.** Compiled from *Demonstrating the Value of British Columbia's Public Colleges*. Retrieved from http://www.bccolleges.ca/wp-content/uploads/2014/02/Agg_BC_MainReport_2013_Finalv2.pdf

[68] **University of Manitoba.** Compiled from Price Waterhouse Coopers (2009). *University of Manitoba Impact Analysis.* Retrieved from http://umanitoba.ca/images/2009_U_of_M_Economic_Impact-_Final_Oct_9_09.pdf

[69] **Dalhousie University.** Compiled from Gardner Pinfold Consulting Economists Ltd. (2011). *Economic Impact Analysis Dalhousie University.* Retrieved from http://www.dal.ca/content/dam/dalhousie/pdf/dept/senior-administration/2011-dalhousie-eia.pdf

[70] **University of New Brunswick.** Compiled from Lantz, V. A., Brander, J. R. G., Yigezu, Y. A. (2002). *The economic impact of the University of New Brunswick: estimations and comparisons with other Canadian Universities.* Retrieved from http://www.unb.ca/rpb/_resources/pdf/factspublic/economicimpactunb.pdf

	Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
Indicators and descriptors utilized												
Operations – baseline metrics												
Institutional expenditures												
Operations	X		X	X	X	X	X	X	X	X	X	X
Student aid	X		X			X	X	X				
Capital				X		X	X			X	X	X
Capital depreciation amortization									X			
Institutional employment			X									
FTE and/or FT & PT	X	X		X					X	X	X	X
Salary and benefits/payroll	X		X	X	X	X	X	X	X	X	X	X
Employee benefits					X							X
Institutional income sources												
Tuition				X					X			X
Federal grants and contracts (non-R&D)				X					X			X
Provincial grants and contracts (non-R&D)				X					X			X
Non-government income				X					X			X
Research	X										X	
Other external to institution												
Alumni	X	X										
Affiliated institutions												
Extension/experimental stations												

	Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
Other (e.g., FIC[71] at SFU)												
Students			X									
Student numbers	X	X	X	X		X	X			X	X	X
Split by FT, PT				X			X	FT	FTE			
By credential level	X		X	X		X		X	X			
Prov/State inflow of students (No.)									X	X	X	
Student spending												
Off-campus expenditures	X		X		X	X	X		X		X	X
By credit students								X				
By students in continuing studies								X				
Students staying in province post-graduation				X		X					X	
Added employer income (a)[72]				X								
Part time work – students												
Student placements, coop, internships												
Employment												
Employment status of graduates				X								
Employment by occupational group				X								
Diverse learning initiatives												
Professional and high-demand offerings												

[71] Fraser International College

[72] (a) = Added employer income ~= Student productivity effect

	Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
Workforce training/work to learn												
Non-credit offerings/students			X									
Community-based learning /service learning												
Out-of-province and international students												
Number and % of PSE								X	X	X	X	X
GDP impact									X	X		X
Employment/FTE impact										X	X	
Income impact										X	X	
Tax revenue (and related)										X	X	
Graduate student prestige and impact												
Visitor spending	X		X			X	X					
Types of visitors			X				X			X	X	X
Number	X		X			X	X	X		X		X
Length of stay	X		X			X	X	X		X		X
Spending per day	X		X			X	X	X		X		X
Spending			X		X	X	X	X		X	X	X
Economic indicators												
I-O overall – through direct expenditures												
Overall $$/GDP impact	X		X							X	X	X
As % of provincial GDP	X (5%)									X		X
As % city/local region GDP										X		X

			Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
		Jobs generated/FTE impact										X	X	X
		Collateral income from jobs elsewhere										X	X	
		Tax revenue										X	X	
		Incremental earnings										X		
	Integrated investment value					X								
		Net present value of benefits				X								
		Rate of return				X								
		Benefit-cost ratio				X								
		Payback period				X								
	I-O Institutional spending (including staff salaries)		X		X									
		Direct			X		X			X	X	X	X	X
		Indirect					X			X	X	X	X	X
		Induced			X						X	X	X	X
	I-O Student spending		X		X									X
		Direct			X		X			X				
		Indirect					X			X				
		Induced			X									
	I-O Visitor spending		X		X									X
		Direct			X		X			X		X		
		Indirect					X			X		X		
		Induced			X							X		
	Education premium/incremental earnings		X		X		X	X	X				X	

			Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
		By degree level	X		X			X		X			X	
		By field of study												
		Private benefit				X								
		Opportunity cost of education				X		X					X	
	Student productivity effect													
		Direct									X			
		Indirect									X			
		Induced									X			
		As % of province										X		
	Investment analysis (student)/private rate of return							X						
		Net present value of benefits					X	X			X		X	
		Rate of return/ROI				X					X			
		Benefit-cost ratio									X			
		Payback period									X			
	Investment analysis (society)/social savings					X							X	
		Net present value of benefits									X			
		Rate of return												
		Benefit-cost ratio									X			
		Payback period												
	Investment analysis (taxpayer)/socio-democratic returns												X	
		Net present value of benefits									X			

			Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
		Rate of return					X				X			
		Benefit-cost ratio									X			
		Payback period									X			
	Ecosystem impact of capital projects											X		
	Spending multiplier													
		Institutional $$$	X											X(1.7%)
		Government $$$	X											X(3.9%)
	B/C Ratio													
		Social B/C ratio				X								
		Gov't investment B/C ratio			X	X						X		
	Internal rate of return				X									
R&D and innovation														
	Financial flows													
		Research funding	X		X			X	X			X	X	
		Research funding from industry			X			X	X			X		
		University R&D spending								X				
		Indirect cost recoveries												
		Income from licensing and royalties			X			X	X	X		X	X	
		Value – equity portfolio							X					
	Prestige indicators													
		CRCs and CERCs	X									X	X	

		Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
	Others	X									X		
Bibliometrics													
	Volume (numbers of publications)			X				X					
	Quality proxies			X								X	
	National and international collaborations												
Technology transfer													
	Patents filed incl. by country			X			X	X	X				
	Licenses granted and executed			X			X	X	X			X	
	Cumulative licenses			X			X				X		
	Invention disclosures			X			X		X		X		
Industry contract work													
Separate joint projects and consultancy													
Start-up and spin-off firms/yr							X						
	Number			X				X	X		X	X	
	By co. name, sector and/or employment stats												
	By type, differentiated										X		
	Currently active/total			X			X	X					
Research collaborations/civic engagement													
Incubated companies													

			Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
	Research impact		X											
		On GDP/GDP growth	X		X			X	X	X				
		Total factor productivity	X		X			X	X	X				
	R&D shares													
		Institution as % of provincial PSE R&D	X		X			X	X					
		HE as % of provincial R&D	X		X			X	X					
	Productivity gains using methodology of F. Martin													
	Induced/dynamic rate of return				X									
	Research park													
	Specialized institutes													
Diverse														
	Local indicators													
		Local content of expenditures												
		Location of employees residence									X			
		Impact on various regional population, employment stats												X
	Innovation and entrepreneurship													
		Organizations created		X								X		
		Employment in orgs created		X								X		

			Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
		Revenues in orgs created		X								X		
		Revenue, provincial GDP		X										
		Revenue per employee		X										
		Organizations created per founder		X										
		Measure of most impactful experiences		X										
		Entrepreneurial supports												
	Innovations (ever) of alumni and time													
		Peer-reviewed paper		X										
		New processes, products, services, business models		X										
		Design, educational, literary, artistic creation		X										
		Patents		X										

	Alberta	Alberta* (E&I)	Calgary	AB Colleges	BCIT	UVic	UBC	SFU	BC Colleges	Manitoba	Dalhousie	UNB
Tax revenue generated for government												
Income generated for government					X							
Economic impact of tax revenue					X							
Outreach and community engagement												
Other												
Sensitivity analysis				X					X			
Comparison with others – benchmarking	X		X									
Contextual positioning												
Profile by economic sector											X	
Revenue									X			X
Jobs									X			X
Regional												
Strategic focus												

Table 3: US Postsecondary Institutions

	Notre Dame	Boston U.	Montana State	Brown	Rhode Island
Methodology	I-O	I-O	I-O + regional elements (including extension)	I-O	I-O
Source	External[73]	Internal[74]	Internal[75]	Internal[76]	External[77]
Year of study	2013	2008	2010	2012	2012

[73] **Notre Dame University.** Compiled from Appleseed (2013). *The Economic Impact of the University of Notre Dame*. Retrieved from *http://impact.nd.edu/assets/113130/notre_dame_economic_impact_full_report.pdf*

[74] **Boston University.** Compiled from *Making a Difference in Massachusetts*. Retrieved from http://www.bu.edu/esi/files/2009/08/esi-2008.pdf

[75] **Montana State University.** Compiled from *Economic Impact Study.* Retrieved from www.montana.edu/

[76] **Brown University.** Compiled from *The Economic Impact of Brown University*. Retrieved from. http://brown.edu/about/reports/economic-impact/

[77] **The University of Rhode Island.**· Compiled from Appleseed (2013). *The Economic Impact Of The University Of Rhode Island*. Retrieved from http://web.uri.edu/economic-impact/files/URI_Economic_Impact_full.pdf

		Notre Dame	Boston U.	Montana State	Brown	Rhode Island
Indicators and descriptors utilized						
Operations						
	University expenditures – operations		Dir, I	X		X
	University expenditures – capital	X (ID'd)			Dir, FTE	Dir, FTE, I,
	Student off-campus expenditures	FTE, Dir, I & Ind	Dir, I	X	X	Dir, FTE, I,
	University employment	FTE	FTE		X	FTE & % FT
	- Employee benefits		X			
	- Employment by occupational gap	X				
	Capital depreciation amortization					
	Income	X	X			X
	- Tuition			X		X
	- Impact on various regional population, employment					
	- Extension and experimental stations			X		
Contextual positioning		X		X	X	

		Notre Dame	Boston U.	Montana State	Brown	Rhode Island
Economic Impacts						
	GDP					X
	Salaries & benefits – employment	Dir, I, Ind	Dir, I		FTE, Dir, I & Ind	FTE, Dir, I
	- Location of employees residence	X				
	Local content of expenditures	Dir, I. Ind	Dir, I		FTE, Dir, I & Ind	FTE, Dir
	Income external to university	X	X	X		X
	Tax revenue	X	X	X	X	
	Visitor spending	FTE, Dir, I & Ind	Dir, I	Dir	FTE, Dir, I & Ind	FTE, Dir, I
Students						
	Student numbers	X	X	X	X	X
	Prov/State inflow of students (No.)	X	X			
	Credential levels	X				
	Students staying in state post-graduation	X	X		X	X
	Benefit/$$ by credential level/discipline		X			
	Earnings differential	X	X			X
	Added employer income (a)					
	- Part-time work – students					
	- Student placements, coop, internships	X				

		Notre Dame	Boston U.	Montana State	Brown	Rhode Island
	Employment status of graduates	X				
Out-of-state and international students						
	Number and % of PSE					X
	GDP					
	Employment					
	Income					
	Tax revenue (and related)		X			
Diverse						
	Social savings[78]					
	Socio-democratic returns[79]				Qual	
	- Outreach and community engagement					X
	Professional and high demand offerings				Qual	
R&D and innovation						
	Research funding by source	X		X, FTE equiv	X	X
	University R&D spending as % of state					
	- Indirect cost recoveries			X		
	CRCs and CERCs (equivalents)					
	Bibliometric indicators					

[78] Social benefits = 1) increased income in the province, and 2) social externalities stemming from improved health, reduced crime and reduced unemployment savings, and 3) income assistance savings.

[79] Socio-democratic returns = Development of a HQ labour force, increased capacity for retirement savings, lower reliance on public pension funds, decreased health care costs, increased earnings & marginal tax impacts, decreased risk of unemployment & periods of low income, the impact of knowledge creation & transmission on ecosystem growth and well-being

		Notre Dame	Boston U.	Montana State	Brown	Rhode Island
	Patents filed by country	X			X	X
	Licenses granted and executed	X		Qual	X	X
	Income from licensing & royalties				X	X
	Cumulative licenses			Qual		
	Invention disclosures			Qual		X
	Industry contract work					
	- Separate joint projects & consultancy			X		
	Start-ups and spin-off firms/yr.	X		Qual	X (Qual)	X
	- Start-up co. name, sector and employment				some	Qual
	- Start-up companies differentiated					
	- Start up companies currently active			Qual		
	Total factor productivity					
	- Workforce training					
	- Community-based learning	X				
	Research park	Qual			Qual	
Ecosystem indicators						
	University as % of local economy					
	University as % of state economy					

		Notre Dame	Boston U.	Montana State	Brown	Rhode Island
Spending multipliers						
	Institutional $$$					
	Government $$$					
ROI and benefit-cost						
	Student ROI[80]					
	Social B/C ratio					
	Gov't investment B/C ratio					
	Internal rate of return					
Other						
	Sensitivity analysis					

[80] "ROI" is similar to the benefit-cost ratio except that the numerator used in the calculation is the net present value of the benefits as opposed to the present value.

Table 4: UK Postsecondary Institutions

		Heriot Watt	**St Andrews**
Methodology		I-O	I-O with Regional Impacts
Source		External[81]	External[82]
Year of study		2012	2012
Indicators and descriptors utilized			
Operations			
	University expenditures – operations	X	X
	University expenditures – capital	X	X
	Student off-campus expenditures	X	
	University employment	FTE	
	Capital depreciation amortization		
	Income	X	
	Impact on various regional population, employment		X
Contextual positioning		X	X
Economic Impacts			
	GDP		
	Salaries and benefits – employment	Dir, Indirect	
	Local content of expenditures		
	Income external to university		
	Tax revenue		
	Visitor spending	GVA and jobs	

[81] **Heriot-Watt University.** Compiled from BiGGAR Economics (2012). *Heriot-Watt University: Economic Impact Study.* Retrieved from http://www.hw.ac.uk/documents/Heriot_Watt_University_Economic_Impact_Report.pdf

[82] **University of St Andrews.** Compiled from BiGGAR Economics (2012). *Economic Impact of the University of St Andrews 2011-12*. Retrieved from https://www.st-andrews.ac.uk/media/university/abouttheuniversity/economic-impact-report-2011-2012.pdf

		Heriot Watt	St Andrews
Students			
	Student numbers	X	
	Provincial inflow of students (No.)		
	Credential levels		
	Students staying in area post-graduation	X	
	Benefit/$$ by credential level		
	Earnings differential	X	X
	Added employer income (a)		
	Part-time work – students	X	X
	Student placements, coop	X GVA and FTE	
Out-of-province and international students			
	Number and % of PSE	X	X
	GDP		
	Employment		
	Income		X
	Tax revenue		
Diverse			
	Social savings (c)		
	Socio-democratic returns (d)		
	Professional and high-demand offerings		
R&D and innovation			
	Research funding by source		
	University R&D spending as % of provincial		

		Heriot Watt	St Andrews
	CRCs and CERCs (equivalents)		
	Bibliometric indicators		
	Patents filed by country		
	Licenses granted and executed	X	
	Income from licensing and royalties		
	Cumulative licenses		
	Invention disclosures		
	Industry contract work	X (profile)	
	Separate joint projects and consultancy	XX	
	Start-up and spin-off firms/yr		
	Start-up co. name, sector and employment	GVA & FTE	
	Start-up companies differentiated	GVA & FTE	
	Start-up companies currently active		
	TFP		
	- Workforce training	X	
	Research park	GVA & FTE - Dir,I	
Ecosystem indicator			
	University as % of local economy		X
	University as % of provincial economy		X
Spending multiplier			
	Institutional $$$	GVA & jobs	
	Government $$$		
ROI and benefit-cost			
	Student ROI (b)	X	

		Heriot Watt	**St Andrews**
	Social B/C ratio		
	Gov't investment B/C ratio		
	Internal rate of return		
Other			
	Sensitivity analysis		

Appendix D – Details on Evaluation Terminology

Evaluation terminology is useful in that it usefully separates out different components of a value chain to clarify exactly who is doing what, and how and when.

Activities – These are the "upstream" things that the institution or an individual program does as an organization. Activities are always "internal" to the institution or its programs; e.g.,

- for research grant management, the institution (or certain types of programs such as those associated with the Networks of Centres of Excellence) monitors and accounts for grant and partner funding and expenditures, conducts audits as required, reports to funding bodies, etc.;
- for proposals made to external organizations such as Genome Canada of the Canada Foundation for Innovation(CFI), it may strike a committee to review those proposals, help refine proposals, select only a certain number to proceed, etc.;
- for major collaborative research initiatives, it may conduct negotiations, sign agreements, provide partner funding, many of which may provide additional "input" R&D funding, etc.;
- for new training initiatives, it may consult with stakeholders as to the academic and community needs, develop curricula, conduct outreach to attract top students and PDFs, etc.
- for work-place training and co-op programs the institution may engage in extensive relationship building with local, regional and even national organizations – private and public sector.
- for public and community outreach, it may develop and maintain a website, hold information sessions, support symposia and conferences, maintains a resource website, etc.

Outputs – These are the immediate products resulting from these institutional or program activities; these are usually "internal" to the institution or its programs[83], e.g.

- major grants are obtained, research is conducted, publications are produced, academic presentations are made, patent applications are made and granted;
- HQP are trained and graduated;
- contracts or memorandums of agreement (MOUs) for major collaborations are signed;
- policy makers, the public, and industry and health care providers are provided with useful information;
- community liaison and outreach programs and products.

Outcomes – What results "downstream" from using the research, training, outreach, and other outputs; the outcomes of interest are generally (though not exclusively) "external" to the institution or a given program, e.g.:

- the knowledge base about a given field of research is strengthened;

[83] Evaluation "inputs and outputs" are different from Input-Output modeling "inputs and outputs"; see sections 1.4 and B.2

- research capacity in many fields is increased both within the institution and within external partner organizations (e.g., from using research findings, from participating in the R&D, from hiring HQP);
- new industrial clusters develop within the region;
- graduates are well equipped to find employment;
- government policies, regulations and codes of professional practice are more evidence-based;
- medical diagnostics, therapeutics and prognostics are improved;
- the institution or program is recognized as a world-class R&D and training resource;
- the local community is stronger, more resilient, safer, more cohesive, more creative, more knowledgeable, more capable, etc.

Impacts – How those outcomes affect society; these are virtually always external to the institution and its programs/initiatives; e.g.:

- the practical applications derived from translation of research findings and/or improved industrial capacity-building improve the competitiveness and sustainability of individual firms and entire industries, generate new/improved industrial products and processes, allow manufacturing processes to become more efficient, etc. – all of which either generate increased sales revenues and/or reduce costs;
- graduates are employed in positions benefiting from their education, hence contributing to work-place productivity and increased tax revenues;
- improved health care products and practices reduce mortality and morbidity, improves quality of life for patients and their families, provide more patient value (better care for same cost, and/or same care for lower cost), reduce the negative societal impacts of death and disease and injury, improve public safety and security, etc. – all of which also have economic implications (including the economic value patients, their families, and health care providers place on life years saved and increased quality of life, and also the contributions that a healthier and longer-lived population have for regional and national productivity);
- better regulations, policies and codes of practice lead to improved industrial competitiveness (increased sales revenues, lower costs), environmental improvements and their associated reduced costs (e.g., lower remediation costs, lower health care costs associated with effects of pollutants), reduced costs of threats to public safety and security (e.g., higher quality agricultural and food products, reduced problems associated with pests and pathogens), improved government efficiencies (e.g., reduced overlaps and duplications), etc.; and
- stronger and more sustainable communities, with higher employment rates, more jobs in the knowledge economy, lower crime rates and costs for the justice system, fewer diseases and mental illnesses, etc.

The evaluation terminology and framework (also employed in a logic model) is of particular importance in assessing institution-specific impacts that go beyond input-output methodologies.

Appendix E – A Draft Typology of Benefits and Indicators for Universities and Colleges

The types of PSE benefits below are adapted from useful work originally done by the University of Manitoba to suggest a fuller range of impacts expected of universities and colleges than is usually attempted in EIA studies. Note that not all of these are easily amenable to economic quantification.

1. The university/college as a knowledge generator and disseminator

- Human capital
  - Individual acquisition of portfolio of critical thinking, skills and knowledge
  - Enhanced social mobility
  - Capacity to live and work in a global community
  - High-value career opportunities and destinations – within region/province and beyond
  - Salary premium by credential level and type as realized in the region/province
- Education
  - Better teaching
  - New curricula
  - New approaches to pedagogy
- Research
  - Seminal contributions to knowledge and understanding
  - Reputation for world-class research as evidenced by research output (including highly cited work), ability to attract and retain world-class researchers, ability to attract top-quality international graduate students
  - Other indications of impact – e.g., client reports, technical manuals, text books, the media, newsletters, and communications directed towards the general community or to particular industry sectors
  - Diverse "input" measures as proxies for influence and impact, e.g.,
    - External research funding brought into the province
    - National and international partnerships in research
    - Centres of excellence, as evidenced by critical mass, research chairs, specialized facilities
- Public engagement and service
  - Investment in social, cultural and community initiatives and events that can be accessed by the public (including number of staff hours spent)

2. The university/college as a catalyst for economic growth

- Contributing to local/regional economic growth – Type 1 from "financial turnovers" (direct, indirect

and induced, adjusted for leakage and displacement)
  - University operations
  - Employee spending
  - Capital expenditures
  - Net influx of students to region from RoC and international
  - Student spending and PT work
  - Visitor spending – whether university-linked or leisure
- Contributing to local/regional economic growth – Type 2 from value-added university/college activities entailing commercialization and/or knowledge exchange
  - Start-up companies (created by graduates); spin-out companies (created to exploit technology developed by U); spin-in companies (created by existing/former employees of the university, with the expectation that the "mother ship" will acquire if successful). Consider on cumulative basis, with earnings and employment.
  - Entrepreneurship development – trends in creation of companies by graduating entrepreneurs by years from graduation, location, economic footprint and sustainability
  - Licensing of technology developed by university
  - Consultancy for local business (for reports and advice, not research activities per se)
  - Collaborative research partnerships
  - Foregone costs resulting from implementation of institutional advice and/or technology
  - Continuing professional development opportunities for regional business/industry, social service and health care providers
  - Student work placements in regional businesses and government and other forms of experiential and service learning
  - Direct financial return to the institution
- Supporting the distinctive needs and growth of the region/province (more qualitative than the above)

  Training – tailoring educational and training programs and services relevant to the region
  Urban development – support through
    - Reputation of the institution as an attractor for location/relocation of business to the region
    - Active engagement in a regional cluster
    - Creation/maintenance and activities of a research park and/or incubator that would not otherwise exist
    - Enhancement of new and emerging business sectors, e.g., creative and green industries
- International linkages and outreach-both direct support and through international alumni
- Highly specialized health and research services (case studies important here)
- Expertise and support provided to community NFPs and other social groups
- Specialized facilities available to local/regional business and government ministries

- International economic activity
  - Contributions to region's export earnings
  - An attractor for foreign direct investment in the region
  - Postsecondary education as an export industry

3. The university/college as a community, regional and national resource

- Local and regional
  - A learning environment for the community
    - Community education
    - Enhancing the skill profile of the region
    - Improving educational attainment of the region
  - A source of knowledge and assistance
    - Student volunteering
    - Shop-front assistance centres for local organizations (government, NFP, business)
    - A climate that facilitates change – informing the community about critical issues
  - A source of culture and recreation
    - Museum collections, art galleries
    - Theatrical and museum productions
    - Sports and recreational facilities
    - Festivals
  - Revitalization of the local community
    - Economic diversification
  - Improved safety and security
- National/international
  - A source of evidence for policy and programs
    - Submissions to government inquiries
    - Expert participation in advisory committees and reviews
    - Efficiency and effectiveness of policies and programs
    - Policy and program development
    - Policy and program evaluation
  - Improved environment
    - Environmental management
    - Environmental monitoring
    - Environmental sustainability

  - Improved professional practice
    - Evolution of core competencies, including professional standards
    - Ethics
    - Social responsibility
  - Improved health and well-being
    - Improved health outcomes for individuals
    - Improved population health
    - More effective and efficient health delivery systems
  - A catalyst for social return/robustness – individual and collective
    - Improved social resilience
    - Decreased income disparities
    - Higher interpersonal trust
- Intangible benefits
  - Provision of a democratic mandate for governmental action
  - National reputation
  - Attractiveness as a place to learn, work and invest

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