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Measuring the Economic Impact of Postsecondary Institutions

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1. Introduction

1.1 Understanding this document

The purpose of this document is to provide a high-level introduction to economic impact analysis (EIA) in a postsecondary education (PSE) context, written for a non-subject-expert audience of postsecondary institution stakeholders. It is intended to serve as broad context for individuals in the postsecondary education community who may wish to measure the economic impacts of their institutions or understand the methods, findings and limitations in studies done elsewhere. The information contained herein is of a general nature and is not intended to be an exhaustive, detailed quantitative textbook in actually conducting such studies, nor is it intended to address the circumstances of any specific individual or entity.

Our procedures consisted of the review of literature on economic impact studies and methodologies. We relied on information and data obtained from publicly available sources, which we did not audit or otherwise verify. Accordingly, we express no opinion on the completeness and accuracy of information provided in this document.

1.2 The organization of this paper

The main text examines the nature of economic impact analysis methodologies and how they can be most usefully applied within the postsecondary education context, including brief discussions of opportunities and challenges, and metrics and methodologies in common use. There are several technical appendices:

- Appendix A presents a summary table of the metrics and methods discussed here, and their pros and cons.
- Appendix B presents far more detail on these topics, including extensive discussion of different approaches and opportunities for improving the state of the art.
- Appendix C presents details on the metrics and methods used by a reasonably representative sample of economic impact analysis studies conducted by postsecondary institutions in Canada and abroad.
- Appendix D discusses details of the terminology used in program evaluation.
- Appendix E discusses a typology of the types of benefits potentially amenable to economic impact analysis.
- Appendix F provides economic impact analysis report references.

1.3 Context

Measurement of the economic impact of postsecondary institutions has become commonplace; what is not so common is consistency of approaches, terminology, methodologies and metrics. Many misunderstandings and confusions result, and readers of EIA studies often find it difficult to reconcile the sometimes very different approaches taken by different reports. In this paper we attempt to describe, at a high level, the underlying assumptions of these different approaches and which work best for a given situation.

In particular, many EIA studies focus quite narrowly – and sometimes exclusively – on metrics that are either mainly "upstream," ones related to the internal operations of postsecondary institutions (e.g., the amount of research funding won), or to short-term flow-through impacts on the local economy (e.g., "multiplier" effects). Several of the most common techniques used employ average factors derived from various studies in literature on economic impacts of research and development and have only limited success at distinguishing different impacts created by different postsecondary institutions.

Conversely, the impacts of most relevance to policy analysts and government decision-makers are the "downstream" value-added aspects that affect external (i.e., non-postsecondary education) stakeholders and arise from the postsecondary institutions' training of highly qualified personnel (HQP), research and community service mandates. But because these downstream impacts are typically much more difficult to define and measure, they are often not measured at all. As things that are not measured are (by implication) sometimes considered unimportant by all concerned, this can easily have the unintended effect of dampening postsecondary activities and outputs that foster such impacts. In this paper we present a wide variety of metrics and methods that can illuminate the comprehensive body of impacts created by postsecondary institutions.

1.4 Terminology – boring but important

Overview. Terminology is rarely a very exciting topic but bear with us for a moment. Terminology is surprisingly important in the economic impact analysis field, being complex, frequently contradictory and quite confusing. Many organizations define "impacts" very loosely and different studies use different definitions (either formally or implied). There are two main types of terminology: (1) adapted from the program evaluation field, and (2) from input-output methodologies used in the micro/macro economics fields. Even more confusingly, input-output studies are frequently referred to as "economic impact analysis studies." They are one kind of EIA study but far from being the only kind.

Evaluation terminology. Evaluation terminology separates the components of a value chain to clarify how *successful* the institution's programming has been. Key evaluation terms (see Appendix D for more detail) are:

- **Activities** are the "upstream" things that the institution does. Activities are always "internal" to the institution. Often "inputs" such as research revenues are tracked within this category.
- **Outputs** are the immediate products resulting from these institutional or program activities, such as graduates or publications; these are also generally internal to the institution or its programs.
- **Outcomes** are what result "downstream" from using the research, training highly qualified personnel, community outreach and other postsecondary education outputs. Outcomes are generally "external" to the institution or a given program.
- **Impacts** are how those outcomes affect society. These are virtually always external to the institution and its programs/initiatives; e.g., they are factors such as increased industry revenues, improved health, a more sustainable environment, a more knowledgeable and just society, etc.

"Evaluation impacts" are what we mainly discuss in this paper. "Evaluation impacts" happen (for the most part) along a time continuum. The more successful the institution's training, research, technology/knowledge transfer and community engagement, the greater the evaluation impacts will be. Creating high "evaluation impacts" does not always correlate with the amount of money spent.

Input-output terminology. I-O studies estimate the direct, indirect and (sometimes) induced impacts of how an organization's *spending* effects on the local economy. Key metrics are:

- **Direct impacts** are caused by the institution's primary expenditures and other economic activities related to their services. Typically these are the costs of the goods and services purchased in the local economy.
- **Indirect impacts** are created by the support and supplier industries that provide those goods and services to the institutions.[1]
- **Induced impacts** are further ripples from direct and indirect expenditures, especially the effect of new jobs and additional household incomes within the economy, as employees re-spend a portion of their income.

The easiest way to produce high "I-O impacts" is to spend large amounts of money. It does not matter what initiative this money is spent on or whether the initiative succeeds, so long as the money is spent locally. Two postsecondary institutions with similar spending profiles will create very similar I-O impacts, even if one is a blinding success and the other is an utter failure. For that matter, a tax-supported postsecondary institution and a tax-supported sports complex or museum with a similar level of local spend will create similar I-O impacts, regardless of the fact that their role and intended impacts on the community are very different in nature.

1.5 What should ideally be measured?

Key postsecondary education impacts. Postsecondary institutions can create significant socioeconomic impacts if they achieve their mandate. Here we use the term "socioeconomic" deliberately, as postsecondary institutions have many important impacts that are not primarily related to financial impacts or impacts for industry, which is often how the term "economic" is conceived. A short list of how postsecondary institutions can produce socioeconomic impacts (see Appendix E for more detail) is:

- *Spending and re-spending* in the local community and nearby region, generating local economic activity;
- *Training highly qualified personnel (HQP)* at all levels[2] who go on to generate economic impacts directly for their employers (e.g., through increased productivity), by creating new start-up businesses, and/or through broader knowledge and technology transfer to their employers and society. A sub-set of HQP impacts is:

[1] Associated impacts such as taxes returned to governments and job creation (calculated from average near-term salaries and wages paid, not on new long-term jobs created in new companies or industries) are usually included as well.

[2] Undergraduate, master's, PhD, postdoctoral fellows (PDFs), technicians, research associates, diploma programs, trades certificates, 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)* that has practical applications for Canadian industry and society; e.g., new products and processes, better policies and regulations, improved health care protocols, healthier environment, increased "know-how", better strategies, new partnerships and supply chains, etc.;
- *Strategic interactions between the postsecondary institutions and the broader community* that foster and enhance diverse impacts such as new knowledge or industry clusters, improved social equity or better decision-making which may eventually lead to economic impacts such as lower costs, new business enterprises, stronger linkages among postsecondary institutions and various community organizations, value chain links, etc.

Within each of these, there are benefits that arise in the immediate, mid and long terms. Further, much value arises through indirect and non-linear routes (e.g., unintended benefits in unanticipated disciplines and sectors), often over very long timeframes and through routes that are unexpected and even completely unknown to the institutions and their faculty members and staff. While a comprehensive analysis of postsecondary education impacts would ideally investigate all of these broad categories, routes and timeframes, the methodologies required would run the gamut from inexpensive and easy (addressing direct, short-term impacts) to costly and complex (the opposite).

Logic charts. 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. They are usually presented as a graphic and are useful for assessing:

- The true logical structure of the organization's programs in the context of its intended outcomes and impacts. Is the "logic" in fact logical? Often one can see weak linkages or entire gaps in the logic.
- Possible ways of monitoring, evaluating and reporting on performance. If the logic chart is complete, one can usually identify metrics to measure many elements in the chain of events and outcomes.
- Possible strategic opportunities. One may see ways to strengthen the organization's high-level strategic goals, including ideas about the assets and activities necessary to achieve those goals.

The study team notes that too often logic charts are simply used as a "feel good" document to justify existing programming. If used instead as an analytical tool to identify strategic and programmatic gaps and opportunities, they can be quite powerful.

1.6 What is actually measured?

Economic impact analysis studies in the postsecondary education field frequently use some mix of "Input-Output impacts" and "evaluation impacts." To assess what is actually done in the field, 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. There are several striking features of this analysis (presented in detail in Appendix C):

- There is a huge variety of approaches, methodologies and specific metrics employed world-wide by postsecondary institutions. There is no magic bullet that is considered “state-of-the-art” by a majority of institutions.
- Postsecondary institutions very commonly do basic “bread and butter” I-O studies that have been generally accepted by the academic community and government funders in the past.
  - Many recent I-O studies also include some additional analyses related to the training of highly qualified personnel and research that go some ways towards trying to assess downstream impacts of these activities.
  - Unfortunately, many studies rely on generic techniques that miss many important downstream impacts and do not easily distinguish among individual institutions;
- Studies that assess downstream impacts are far less commonly used. Where they are investigated, generic methods that apply at a national level are far more frequently employed than institution-specific ones (quite likely because the former are easier to use).
  - However, even where quite simple downstream impacts are involved, (e.g., traditional technology transfer involving patents, licensing and start-ups), these are often not reported in EIA studies.
  - This neglect of downstream impacts is even more true where non-traditional technology transfer, indirect routes or societal benefits are involved.
  - Similarly, important "process" indicators such as long-term, two-way relationships between researchers and end users (which the authors have found to be tremendously important for generating downstream benefits) are rarely reported (or presumably assessed).

In short, most approaches are relatively simple, inexpensive and limited. There is no single comprehensive, multidisciplinary, multi-sectoral and robust method for identifying and quantifying the true long-term socioeconomic impacts associated with postsecondary education mandates. Such methods exist but: (1) they are time- and resource-intensive; (2) funders have not required them; and (3) in general, institutions have not recognized their power in helping explain their achievements to funders and the general public, and in helping the institutions improve their internal strategies.

What to do? The authors believe that the key thing to bear in mind is to try to measure impacts 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, and the reason postsecondary education institutions are provided with public funding. Postsecondary education institutions exist not to spend money in the short term (the root metric that drives input-output analysis) but to generate educational, research, innovation and community impacts beyond the walls of the academy and over the long term. In practice, this means thinking more about “evaluation impacts” than “I-O impacts.” And, of course, define (and think about) “impacts” very clearly!

2. Metrics and Methodologies

2.1 Measurement is quantum

First, another tiny bit of definition:

- "Metrics" (sometimes called "indicators") are ways in which you will assess the presence and magnitude of each impact of interest. These may be either quantitative (e.g., number of highly qualified personnel, dollars) or qualitative (e.g., improved societal well-being);
  - The choice of metrics is of paramount importance, as this defines what is thought to be important to measure.
- "Methodologies" are simply the ways that you might obtain data on these metrics/indicators and the ways in which the data might be analyzed.

There is an important wrinkle here: "measurement is quantum"[3] – measurement (and especially the metrics used) can easily change how institutions, faculty members and staff behave because they are implicitly being rewarded for achieving high marks on those metrics. Conversely, they are implicitly discouraged – and sometimes actively punished – for pursuing impacts that are not captured in the metric system.

Thus the choice of metrics has significant effects all on its own – positive if the metrics align with the true long-term goals of the institution, but negative if not. This can be a powerful effect, as researchers' career paths are influenced by "looking good" on institutional metrics, while the ability of institutions to obtain resources equally depends on looking good on the metrics chosen by funders. As a simple example, looking good on "I-O metrics" mainly depends on spending a lot; looking good on "evaluation metrics" mainly depends on benefitting society.

2.2 Spending and re-spending impacts in the local economy

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.[4] A typical I-O study will estimate the direct, indirect and (sometimes) induced impacts of an organization's effects on the local economy. In addition, most I-O studies also include metrics that estimate the number of jobs supported (again, on a direct, indirect and induced basis), as well as local, provincial and federal taxes that result, and they include GDP effects as well.

[3] Apologies to physicists everywhere.

[4] 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, or the broader metropolitan area surrounding it, or even the entire province or country. It is common, however, for national effects to be excluded, and international effects are always excluded.

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

Multipliers. The sum of direct and indirect impacts together, as compared to the direct impacts alone, reflects the local “multiplier effect.” For example, if $1.00 of an institution’s direct impacts result 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.
- Further, the postsecondary institution could be a failure in achieving its mandate (e.g., no graduates, no publications) but still have a multiplier of 2.0 so long as the institution and its suppliers spend their funding locally.

Utility. I-O studies are popular because they are relatively simple to conduct and they reflect the reality that postsecondary education expenditures are tremendously important to the local economy. (One needs only consider a situation where an institution spends all of its money abroad and its suppliers do likewise; this situation would be quite untenable). Further, they are influential with policy-makers and politicians. However, this influence runs two 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 is because the multiplier is usually significantly greater than 1.0 so long as most goods and services are obtained locally, and this is almost universally misinterpreted to mean that the institution or initiative has “made a profit” (or will make one, in the case of planned initiatives). Unfortunately, this is not the case. It only means that most expenditures and re-expenditures happen locally.

Value-add techniques. Some I-O studies go beyond this core analysis of spending and transactional patterns to also 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 for those events, and building “Big Science” facilities that will employ large numbers of additional scientists and staff and attract external scientific teams to the region as visitors. To some extent, these value-add techniques go part-way towards assessing downstream impacts, although they are generally employed ad hoc for planned initiatives rather than as post-hoc assessments of actual success, and they may or may not be related to the long-term core mission of the institution.

2.3 Impacts from training highly qualified personnel (HQP)

Highly qualified personnel – the students and graduates – are rightly considered one of the most important outputs of universities and colleges, but their true downstream economic impacts are very difficult to judge. There are near-term, mid-term and long-term effects.

Near- and mid-term impacts and metrics. A number of different approaches have been used here:

- Near-term – Metrics include the monies that students expend during their university or college tenure on tuition, room and board, textbooks, general living expenses, etc. Often a distinction is made between Canadian and foreign students, 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 EIA study:
  - As a measure of the direct and indirect financial impacts of the students in contributing to the local economy (i.e., as one portion of the I-O output modeling); or
  - As a measure of the cost to students of obtaining the postsecondary training, in which case these expenses would be considered as costs when estimating the return on investment obtained by them after graduation (which is a very narrow view; the ROI could be high for the graduates themselves but low for society)
- Mid-term impacts on individuals – The average wage/salary increment obtained by graduates compared to non-graduates, adjusted for the proportion of graduates who remain in the local economy, measured by:
  - Surveys of graduates and/or employers (which can identify the specific impacts of individual institutions or specialized training initiatives). Note that this requires a method for tracking and contacting alumni and then extrapolating from a sample of respondents. As a result, it is rarely done and is often fraught with low response rates; or
  - Referring to the literature on average postsecondary education-related salary/wage increments – by far the most common.
- Mid-term tax impacts – The incremental wage/salary effect can be used to model the increased taxes that the regional, provincial and federal governments will obtain. (This is often done on a lifetime basis rather than annually, if only because the number is far more impressive.)
  - Note 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. (Though many studies imply it.)
- Mid- to long-term societal cost savings – Occasionally modeled (especially by colleges) is the reduced likelihood that graduates will suffer significant societal problems such as being unemployed, suffering serious life-style related illnesses or disease, or involvement with the justice system, all draining the public purse.

Near- and mid-term methodologies. Short- and mid-term metrics are estimated most easily by reference to published studies, for example academic literature or Statistics Canada data, supplemented by any additional analyses required (e.g., effects on tax revenues). Since these do not assess the individual contribution of a specific postsecondary institution, a few organizations attempt surveys of their current students and/or alumni.

Near- and mid-term incrementality and attribution. A significant issue in the analyses of both future earning potential and reduced societal costs is that the highly qualified personnel are self-selected: they are not likely to be representative of the population as a whole. Thus these effects are likely related, at least in part, to the characteristics of individuals who enter colleges and universities, rather than impacts of the education and diplomas themselves.

Long-term impacts and metrics. Highly qualified personnel also contribute the latest knowledge and expertise to their employers 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. Both factors will contribute to more revenues, cost savings, taxes and job creation[5], as well as other non-industrial impacts in health and health care, the environment, society, etc.

Long-term methodologies. Estimating long-term impacts is time- and resource-intensive, but an excellent way to distinguish one institution from another. For example, an institution 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 will likely find more benefits for local employers of graduates. There is no "one size fits all" methodology but options include those below (which rely on tracking alumni, contacting them, and surveying or interviewing them and/or their employers):

- Case studies of highly qualified personnel associated with specific 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;
- Follow-up studies of alumni and/or their employers investigating the specific contribution of individual graduates to their employers and (possibly) society more generally.
  - A variant is to contact only alumni who are known to have formed their own start-ups, which for institutions known to support innovation (e.g., MIT) can be quite powerful.

Long-term incrementality and attribution. Follow-up studies may also suffer from HQP self-selection, but there is a rather clearer link to the scientific and technical postsecondary training.

2.4 Downstream impacts from using research findings and expertise

Overview. Here is where different institutions can make very distinctive contributions, as the nature and magnitude of impacts depend strongly on the R&D success of its researchers, coupled with 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 impacts to identify, track and quantify, as many are relatively long-term. Further complicating the task is that both direct and indirect routes create impacts, and multiple contributions by multiple other organizations are often important to achieving any single impact.

[5] In this case, "job creation" in the sense of new long-term jobs not supported by postsecondary expenditures.

- **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 firms, new policies and professional practices, better decision-making, changes to corporate business strategies, new partnerships, improved value chains, human resource development and more effective use of "big data." The authors have found that these indirect effects are often considerably more important than direct application of IP. As one example, the firm that designed and built the telescope base for the Canada-France-Hawaii astrophysical observatory used by Canadian academic and NRC scientists was able to win similar observatory contracts world-wide in part because of the "seal of approval" effect (a factor additional to its new technical expertise). However, it was also able to become a world leader in design and construction of high-tech amusement parks rides world-wide because the design requirements and constraints are not dissimilar, and because the NRC scientific leader pointed out the opportunity to the firm, influencing its corporate strategy. Neither of these enormous financial impacts would have been identified by tracking patenting and licensing.[6]

In another example, a firm developing nano-scale sensor technology in collaboration with Canadian scientists was involved in a government-sponsored trade mission overseas to help develop a market for the product. During the course of the trip, the firm became aware of a significant market opportunity in the oil sands industry related to maintenance of very heavy equipment. This opportunity did not require the sensors so much as the remote data logging and analytic systems being developed in conjunction with the sensors. This multi-million dollar market would not have been identified without the serendipitous interactions on the trade mission, triggering the very indirect (but critical) route leading to this market.[7]

- R&D that affects entire industries. This often occurs through open-source IP developed through pre-competitive consortia, or over decades of effort through mutually beneficial and long-term two-way partnerships between researchers and end-users. These frequently have far higher net benefits than R&D that targets individual innovations for individual firms.
  - As another example, the Province of Saskatchewan has funded R&D since the 1980s through its universities, private sector firms and associations, and federal R&D organizations in a wide variety of agriculture and agri-food topics. These have involved both scientific/technical subjects (e.g., tilling practices; seeding techniques; soil and water conservation; use of pesticides, herbicides, and fertilizers; rotation schedules of different crops; and innovative equipment) and also capacity development through a chairs and training program. This led to (among other impacts) an annual increase in seeded land of roughly 30% from baseline, in turn leading to enormous productivity gains across a wide range of crops and producers. Most of these innovations were not patented and the benefits only arose because of wide and proactive dissemination of not only the research findings but also practical advice on how farmers should use them.[8]
  - In another example, R&D into the fundamental physics that underpins how different materials react to physical stressors led to novel ways to machine high-precision parts for the aerospace industry (e.g., turbine blades). The research led to a series of computer models that could be used to identify

[6] Evaluation of the Herzberg Institute of Astrophysics. KPMG Consulting (now KPMG). October 26, 1998.
[7] Summary of results in Return on Investment (ROI) Study – CONFIDENTIAL. Dennis Rank and Associates and J.E. Halliwell Associates Inc., September 11, 2011
[8] Evaluation of the Strategic Research Program (SRP) and Agriculture Development Fund (ADF) Final Report. May 15, 2013, KPMG LLP

machine- and material-specific characteristics that affect yield, precision and rejection rates, and which have led to significant improvements to parts quality and company competitiveness. But much of the benefit has derived from the principal investigator's decades-long relationship with a number of high-tech firms (aerospace and related such as high-speed rail). This has allowed him to visit the shop floor, interact directly with machinists as well as supervisors and CEOs, trade personnel back and forth between his lab and the firms, conduct training seminars and have access to the tools, equipment, materials and techniques in use "in the field" by these companies, all of which are normally considered highly confidential. Here there is a true two-way street and mutual trust without which these impacts would not be nearly so widespread.

- Larger societal – Diverse routes. Probably the most challenging of all to identify are the larger societal impacts of research, including better policy decisions, improved community sustainability and well-being, individual and public health, and better environment. These usually arise from a constellation of factors.
  - As an example, research into genomics-enabled methods for silviculture and reforestation allows better methods for selecting seedlings to plant. These will allow us to replant forests with trees having better resistance to climate change and the insect scourges that are dramatically expanding their ranges to follow warming trends. The scientific and technical challenges, however, can only be implemented successfully in close collaboration with governments (which set regulatory protocols regarding permission for "seed transfer" across geographic and climatic regions), and with forest companies and associated communities which must adapt to new species being harvested, along with new markets for the resulting products and taking into consideration other forest uses such as recreation. An important end result is more sustainable forest-based communities and jobs.

Impacts and metrics. On the industrial side, the metrics are normally easy to specify as they ultimately relate to sales revenues, cost savings and profits.[9] However, there are often intermediary metrics of interest such as increased capitalization and the "process indicators" discussed above under "non-traditional routes," some of which may be far easier to measure (if often more qualitative in nature).

On the societal front, the impacts and metrics are considerably more diverse 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; lower rates of 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 behaviour; higher levels of individual and community happiness and contentment; more personal freedom and flexibility; more effective and equitable legal practices; greater contributions of individuals to society; better interpersonal relationships; improved education; etc. As is likely obvious, there is no "magic bullet" metric here. Although most are inherently qualitative in nature, quantitative techniques exist for monetizing such impacts if required.

[9] An interesting example of how "measurement is quantum" is that an emphasis on creating spin-offs and start-ups often results in a lack of emphasis on cost savings for existing firms. The latter is often much easier to achieve and can lead directly to sustainability of existing firms and critical industries.

Methodologies. There are both top-down and bottom-up methodologies. The former usually involve various average effects derived from the literature and are relatively poor at distinguishing the impact of individual postsecondary institutions or initiatives. Bottom-up methods are typically much better at this task but considerably more resource-intensive to conduct. Some of the key methods employed include:

- **Top-down: Total factor productivity (TFP) methodologies**. Some portion of national GDP growth over time is assumed to result from R&D done in the postsecondary education, private and public sectors that increases the knowledge and innovation of firms and workers.
  - The portion of GDP increase owing to R&D is assumed due to improvements to 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%.
  - 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.
  - Adjustments are made for R&D conducted outside the region, or R&D not done by postsecondary institutions, or R&D not done by the specific institution under study.
  - TFP does not distinguish among postsecondary institutions. Two institutions with the same R&D revenues will be assumed to have the same proportional effect on increases to local GDP.
- **Bottom-up: "Success story" case studies**. These are commonly used by institutions to illustrate particularly interesting benefits or the complex routes that may have led to them.
  - Evaluators may 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.
- **Bottom-up: Outcome Measurement Studies (OMS)**. These techniques developed by the Canada Foundation for Innovation assess the key impacts of major strategic investments made by individual institutions, using a complex case study approach (which includes an expert panel review). OMS is a powerful tool to uncover some impacts that may be unknown even to the institutions themselves and it has led some institutions to modify their strategic planning and organizational structure to best exploit those opportunities. However, it is very resource-intensive.
- **Bottom-up: TRACES and HINDSIGHT:** These were retrospective studies 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. While resource-intensive, they 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.

  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 only the highest impact projects (colloquially, "big winners"), which are those with the highest known impacts, having impacts that can be quantified in dollar terms and where the impacts are attributable to the institution under review (as opposed to other parties).Existing impacts of the "big winner" projects (only) are quantified, modeling anticipated future impacts 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 investigation10). The PBCA then calculates the Net Present Value and Benefit/Cost Ratio, both of which are lower bounds of the total impacts but are highly defensible as all analytic assumptions are laid out in detail.

- **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. Note that patenting is not important in all sectors or for all initiatives – in others, open source IP is more important (e.g., in resource sectors or for many agriculture and agri-food innovations).

2.5 Cluster development

Postsecondary institutions can have significant effects on local clusters of expertise and/or industrial strength. These effects can include any or all of the impacts and metrics discussed above, in that one can assess them in terms of I-O effects on local expenditures in a given type of cluster, or on the development of highly qualified personnel, or on societal and/or industrial competitiveness. However, there are many other factors that affect cluster development, including the transportation network, information technology and communication (ITC) strengths, regulatory and tax environments, access to risk capital, and the like, within which the postsecondary 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 thus there is even less agreement on the best metrics and methods. These analyses are only occasionally attempted in rigorous fashion.

Impacts and metrics. While non-institutional factors (e.g., quality of life, taxes) are often more influential than postsecondary educational factors, investigators have noted that the impacts of university activities on regional economic development, including cluster development, are considerable. These contributions are varied but typically depend on:

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

Both of these are variants of *human capital development* and both are essentially process indicators.

[10] 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.

Methodologies. Both bottom-up and top-down methods have been attempted:

- **Bottom-up: Low effort** – Simpler methods may rely on a review of industry-wide statistics on the growth (one hopes!) in the cluster's firms, jobs and GDP, possibly supplemented by analysis of the industry's structure (e.g., large multinationals vs. SMEs). Input-output analyses are often conducted within this**.**
- **Bottom-up: Medium effort** – These couple simple statistical effects (as in the Low effort option) with investigation of local strategic and market factors that support or inhibit cluster development. These may 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.
- **Bottom-up: High effort** – More complex studies have focused on measuring the downstream effects of postsecondary education on wider conditions in the regional economy, geared to measure the more intangible and non-linear effects of postsecondary education on the generation and sustainability of innovation performance.
- **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.
- **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.

2.6 Impacts related to broader social benefits

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 postsecondary education system. Some are potentially amenable to quantification as well. Recent work has attempted to identify, quantify and monetize the larger social impacts of postsecondary education. 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! 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. These include:

- outreach, communication and education efforts;
- exit survey data and other impact data based on such activities;
- interactions with policy-makers; and
- collaborations with non-industrial end-users (e.g., NGOs, patient advocacy and support groups, environmental groups)

In large measure, methodologies for assessing broader societal impacts (e.g., Social Rate of Return, or SROI) mirror many features of methods such as Partial Benefit-Cost Analysis (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 the incrementality and attribution of the impacts, and establish a value for the total benefits minus costs.

Unlike simple benefit-cost or industrial EIA studies, the benefits in SROI 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.

2.7 Recent trends and specialized approaches

Mixed approaches. 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, which may be of more interest to the institutions themselves for future strategic decisions. Although the metrics used in such approaches are normally not monetized, PBCA or PBCA-like techniques are sometimes employed. 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. 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[11] (discussed further below);
- The CFI Outcomes Measurement Strategy (OMS; discussed earlier);
- The Canadian Academy of Health Sciences (CAHS) framework[12]; and
- Canadian Institutes of Health Research's (CIHR's) performance measurement strategy.

Health care and the Payback Framework. We discuss this approach in more detail because of its recent importance in the health care research field. (The CAHS and CIHR strategies are, in part, based upon it.) 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: knowledge; benefits to future research and research use; benefits from informing policy and product development; health and health sector benefits; and wider social and economic impacts (which include social or economic effects that change society, including impacts on public opinion).

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

11 http://jonathanstray.com/papers/PaybackFramework.pdf

12 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.*

institutions. They do not, however, provide direct insight into the economic impacts from postsecondary education.

Another recent tack is to use "altmetrics."[13] This is a variant of bibliometric analysis that attempts to identify scientific and other outputs, including those in the social sciences and humanities (e.g., datasets, software) that are of interest both to other researchers and potentially broader non-scientific audiences.

2.8 Performance measurement (PM) systems

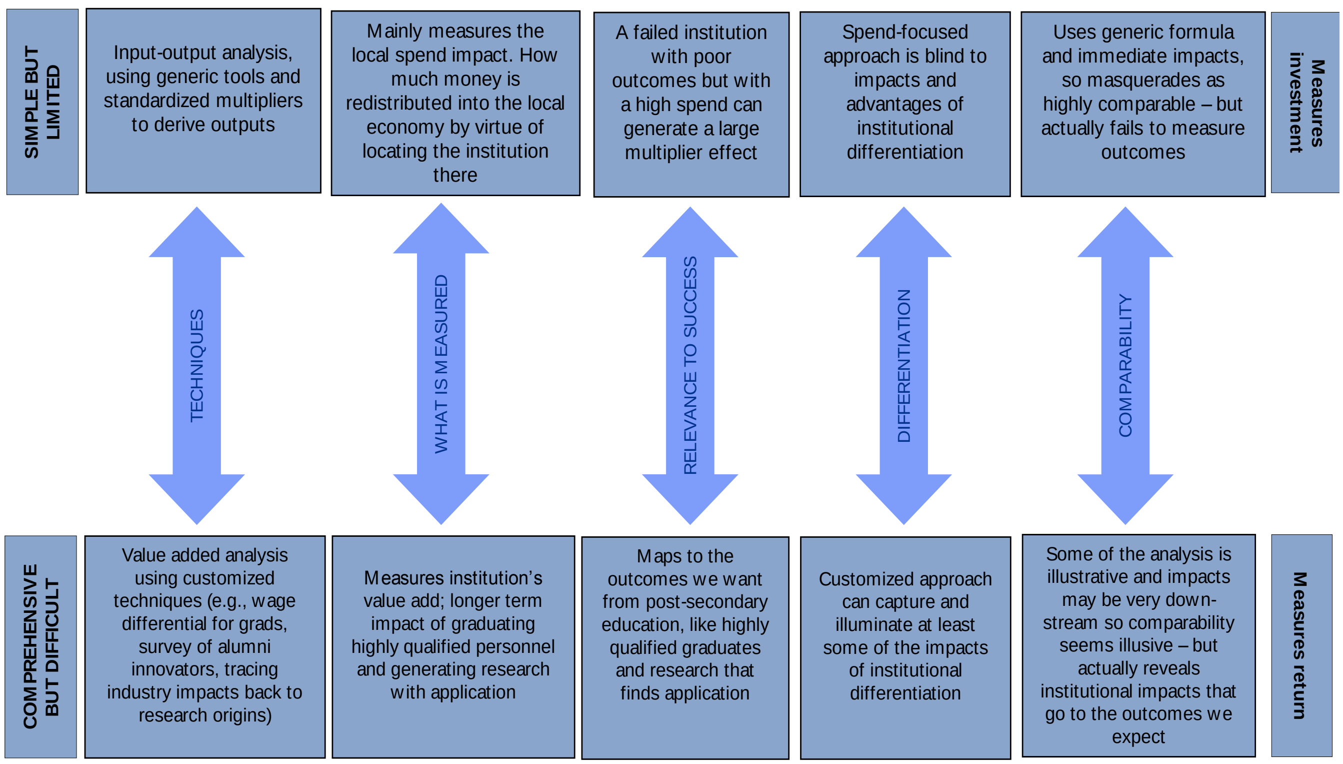
We discuss PM systems as they are often the first point of attention for institutions wishing to document their impacts. PM systems are usually intended for one or more of three main purposes: (1) monitoring performance; (2) demonstrating achievements to external audiences; and (3) helping inform the institution's strategy.

Organizations often attempt to use PM systems to capture important impacts on an ongoing basis, but 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, research revenues obtained, HQP trained), they necessarily 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 through 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. 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.

13 Altmetrics is the study and use of non-traditional scholarly impact measures that are based on activity in web-based environments (PLOS definition). The open access movement has made this an increasingly viable metric.

3. Conclusions

How can we make sense of such a complicated and confusing situation? And in particular, how can postsecondary institutions employ EIA studies to be truly useful for themselves, their researchers and their funders? First, we recap the context in the graphic below:



- There is often a mismatch between what is being measured and the intended impacts of postsecondary education. While there is a certain degree of consistency among some EIA studies (e.g., many or most address input-output measures), this obscures the fact that such measures rarely discriminate among the success of different institutions.
- What would be measured in an ideal world – the true long-term impacts on society, industry, health care and the environment – is quite simply impossible as so many of these impacts happen over very long timeframes and in unexpected and unknowable ways.
  - Frequently, however, many of the relatively simpler aspects within these spheres are not measured either, such as traditional technology transfer to industry.
  - Nor are there many efforts to identify and track the more complex, subtle but very important effects arising through indirect routes, or important "process" paths, or HQP impacts or non-industrial impacts, even though techniques exist, even if imperfect.

- The “measurement is quantum” effect has the real potential to create misunderstandings about what impacts are important and what actions and routes should be taken to achieve them. Thus if postsecondary education institutions ask potentially misguided questions (or incomplete questions) of their faculty members and Industry Liaison Offices, or if governments ask similarly off-target/incomplete questions of the institutions, industry and society may not obtain optimal returns for their investments.
- There is no “one size fits all” solution to these problems but we offer some suggestions:
  - Institutions and governments alike should develop metrics that are as far focused downstream – and external to the postsecondary education institutions – as possible.
  - Institutions should link these metrics to well thought-out logic charts (i.e., ones that have been developed with an analytic eye) that capture overall institutional missions and goals, as well as (separately) those of important initiatives that are sector-, discipline-, problem- or impact-based.
  - The metrics and methodologies employed for EIA should closely mirror these goals and by implication will differ among institutions, occasionally markedly. This implies that governments should not obsess too much about benchmarking one institution against another or against a norm, since these metrics and methods will necessarily differ across institutions and initiatives.
  - Although this lack of consistency may at first blush appear to be a negative, it is actually far more useful than using very simple metrics which, while consistent, are mainly correlated with expenditures rather than success.
  - Such metrics (and especially “stretch” metrics) can be used by institutions to identify important impacts as they arise and to track their success over time as they diffuse through Canadian industry and society. This requires a different approach by institutions and industry liaison offices to developing their performance measurement systems and to conducting follow-up studies, but over time will be far more revealing of their true successes and the routes leading to them. This in turn can help improve programming of all types.

Higher Education Quality Council of Ontario

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