

# INNOVATION IMPACTS: MEASUREMENT AND ASSESSMENT

The Expert Panel on the Socio-economic  
Impacts of Innovation Investments





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Innovation Investments**

## THE COUNCIL OF CANADIAN ACADEMIES

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## The Expert Panel on the Socio-economic Impacts of Innovation Investments

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The Council also recognizes the important contribution of **William A.S. (Bill) Buxton**, Principal Researcher, Microsoft Research (Toronto, ON) to this assessment.

## Message from the Chair

Throughout human history, innovation has been the driving force behind material and social progress. Today, economic and social well-being is perhaps even more intimately tied to innovation — the competitiveness of the business sector and the efficacy of the public sector depend on it. To ensure continued prosperity, governments must commit to innovation as a cornerstone of long-term public policies, creating the conditions and making the investments that are most likely to spur innovation. Effectively enhancing innovation requires governments to have access to reliable measurements of the impact of their investments.

To address this challenge in the Ontario context, the Expert Panel on the Socio-economic Impacts of Innovation Investments was formed. Building on its considerable expertise — as innovators, policy-makers, and measurement experts — the Panel went beyond existing practices around the world and those suggested in the academic literature. Through many deliberations, the Panel developed a pragmatic framework to measure innovation impacts and organize innovation policy thinking. I am confident this report will be an important tool for the Ontario government, and others, in formulating policies and deciding how to best support innovation.

The Panel benefitted greatly from expert witness presentations on best practices in measuring innovation impacts. I would like to thank Kathryn Graham, John Helliwell, Azam Khan, Anita McGahan, Pierre Mohnen, Peter Nicholson, and Steven Young for their authoritative and thought-provoking presentations.

I am very appreciative of the strong commitment, both of time and energy, of my fellow Panel members. Their collective wisdom and insights have resulted in a high-quality and extremely useful report.

Finally, the Panel and I are sincerely grateful to Council staff for their excellent support and help in bringing our ideas to fruition.



**Esko Aho, Chair**

The Expert Panel on the Socio-economic Impacts of Innovation Investments

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## Report Review

This report was reviewed in draft form by the individuals listed below — a group of reviewers selected by the Council of Canadian Academies for their diverse perspectives, areas of expertise, and broad representation of academic, industrial, policy, and non-governmental organizations.

The reviewers assessed the objectivity and quality of the report. Their submissions — which will remain confidential — were considered in full by the Panel, and many of their suggestions were incorporated into the report. They were not asked to endorse the conclusions, nor did they see the final draft of the report before its release. Responsibility for the final content of this report rests entirely with the authoring Panel and the Council.

The Council wishes to thank the following individuals for their review of this report:

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The report review procedure was monitored on behalf of the Council's Board of Governors and Scientific Advisory Committee by **Murray S. Campbell**, Senior Manager, Business Analytics Research, IBM T.J. Watson Research Center. The role of the report review monitor is to ensure that the panel gives full and fair consideration to the submissions of the report reviewers. The Board of the Council authorizes public release of an expert panel report only after the report review monitor confirms that the Council's report review requirements have been satisfied. The Council thanks Dr. Campbell for his diligent contribution as review monitor.



**Elizabeth Dowdeswell, O.C., President & CEO**  
Council of Canadian Academies

## Executive Summary

Innovation is the *sine qua non* of economic and social progress. It is the predominant source of the new or improved products, processes, and methods of marketing and organization that drive the competitiveness of our business sector; generate the income that sustains our standard of living; alter the way we interact with each other and the natural world; and solve (and sometimes create) the technical and social problems we face. The key challenges for most economies — intensifying global competition in product markets, increasing demand for energy and other natural resources, and aging of the workforce — render economic competitiveness transient and easily eroded, potentially compromising the wealth of nations that fail to combat them. In addition, the growing pressure of complex, global challenges, such as climate change and financial system stability, suggests that harnessing the innovative capacity of humanity is more critical than ever before.

Long recognizing the importance of innovation, the Government of Ontario has signalled its clear commitment to it as the centrepiece of economic policy. This commitment is reflected in the establishment of the Ontario Ministry of Research and Innovation (MRI), the development of the Ontario Innovation Agenda, and a varied and generous set of innovation investments. In July 2011, MRI posed the following question to the Council of Canadian Academies (the Council):

*How can the actual and potential outcomes and impacts of Ontario government spending on innovation and scientific activities be measured, including but not limited to the effects on GDP in Ontario, generation and transfer of knowledge; creation of new ventures; and access to seed, development and growth capital?*

In response, the Council appointed a panel of Canadian and international experts (The Expert Panel on the Socio-economic Impacts of Innovation Investments) from the academic, business, and public sectors. To address the charge, and its three sub-questions, the Panel catalogued the portfolio of Ontario innovation investments, conducted an extensive academic and public policy literature review of leading-edge measurement methodologies, and explored the best international practices in impact assessment. Then, drawing on its collective understanding of innovation and experience in impact measurement, the Panel developed a new conceptual framework for understanding innovation measurement and assessment.

## PROGRAM IMPACT MEASUREMENT

Governments are not only faced with competing demands for public funds, but also with increased pressure to demonstrate value-for-money. With a surfeit of public spending priorities, public investments of any kind, including innovation investments, must be seen to generate a significant return. To ensure that innovation investments generate desired returns, are spent most effectively, and remain a priority in the face of austerity measures, the Government of Ontario must obtain the most rigorous and reliable estimates of the impacts of its innovation support programs.

Measuring the impacts of the Government of Ontario's investments in innovation requires four steps. First, cataloguing innovation investment programs highlights what constitutes an investment. At the program level, the Panel identified six classes of Ontario innovation support programs: direct academic support, public and not-for-profit research organizations, innovation intermediaries, direct business support, indirect business support, and public procurement.

Second, identifying program objectives delivers guidance on what impacts to expect — that is, what can and should be measured for a program. The Panel identified the likelihood of seven types of impact for each of the six classes of Ontario innovation support based on stated program objectives (see Table 1).

Third, collecting data, either from administrative records and surveys or through program design, determines the most appropriate measurement technique. The robustness and reliability of an impact measurement depend on the type and quality of data collected. The ability to use sophisticated best practice econometric approaches to program evaluation is sometimes limited by a lack of data.

Fourth, using leading-edge econometric approaches to program evaluation (random field experiments, regression discontinuity design, matching estimation, and difference-in-difference estimation) can provide robust and reliable measurements of program impact. These approaches require skilled and experienced analysts and a significant time commitment to interpret results. The Panel identified how and when to best employ these measurement tools for Ontario's innovation support programs (see Table 2).

Program impact measurement can provide robust and reliable estimates of the returns to innovation investments. There is, however, an important and fundamental trade-off between data requirements and the timeframe in which impact measurement can be conducted and the robustness of these estimates. If the

*Table 1*  
Likelihood of Impact of Ontario Innovation Investment Programs

Program Type	Knowledge Generation	Creation of New Ventures (Entrepreneurship)	Access to Capital	Employment	GDP/ Output	Taxes	Social
Likelihood of Impact							
Direct academic support	High	Low	n/a	Moderate	Low	Low	Moderate
Public and not-for-profit research organizations	High	Low	n/a	Moderate	Low	Low	Moderate
Innovation intermediaries	Low	Moderate	Moderate	Moderate	Low	Low	Low
Direct business support	Moderate	High	High	High	Moderate	Moderate	Moderate
Indirect business support	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate
Public procurement	Low	Low	n/a	High	High	High	High

Table 2

**Suggested Measurement Methodologies by Innovation Program Type**

<b>Program Type</b>	<b>Suggested Measurement Methodology</b>
<b>Direct academic support</b>	Regression discontinuity design Indicator-based frameworks Case studies
<b>Public and not-for-profit research organizations</b>	Indicator-based frameworks Case studies
<b>Innovation intermediaries</b>	Random field experiments Matching estimation Client-based surveys
<b>Direct business support</b>	Random field experiments Matching estimation Client-based surveys
<b>Indirect business support</b>	Regression discontinuity design Difference-in-difference estimation
<b>Public procurement</b>	Difference-in-difference estimation Matching estimation

goal of measurement is to produce estimates of *short-term* impact, the best source of data is a properly designed client-based survey that minimizes the subjectivity of responses. If the goal of measurement is to firmly establish rigorous, reliable, and *long-term* causal estimates of program impact, state-of-the-art approaches, like random field experiments and regression discontinuity design, require a specific program design, a substantial quantity of data, and a significant amount of time. Ultimately, the feasibility of a measurement methodology depends not only on the goals of measurement, but also on the objectives and structure of an innovation program, which determine the expected socio-economic impacts.

**INNOVATION ECOSYSTEM ASSESSMENT**

Program impact measurements alone cannot capture the nature of innovation. Innovation is not a process isolated at the program level, with a linear relationship from investment to impact. Assessing the full impact of innovation investments requires capturing their contributions to the functioning of the entire innovation system. The Panel developed its firm-centric innovation ecosystem framework that conceptualizes innovation as the result of an intricate set of activities and linkages between innovation actors. The sheer volume of interactions and complicated feedback loops makes it difficult to understand the workings of an innovation

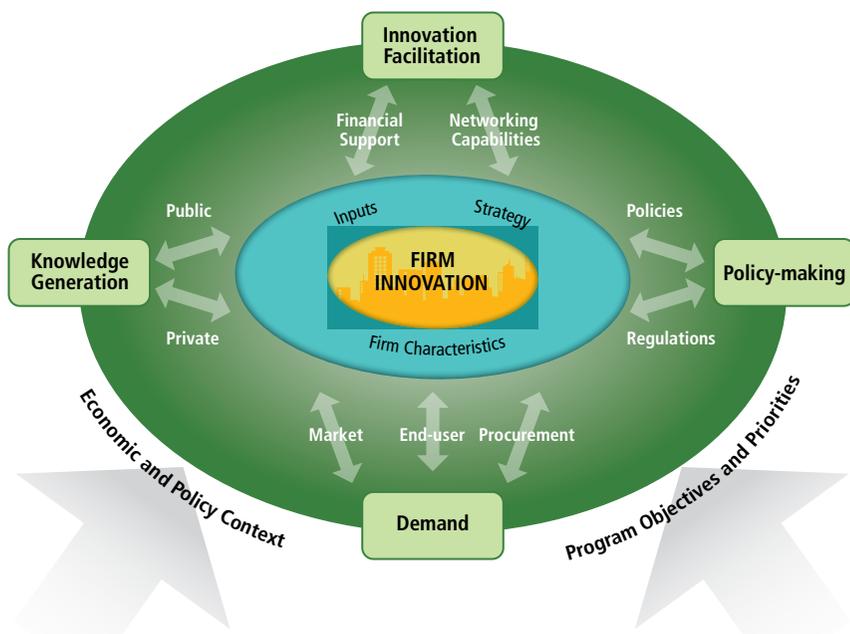
ecosystem at the micro level. Instead, the crucial components for analysis are the key aggregate behaviours that emerge from this network of micro-interactions (as illustrated in Figure 1):

- *Knowledge generation* – Created in universities, colleges, public research organizations, governments, and firms, and codified in the forms of publications/patents/products or embodied in human capital, knowledge represents the ideas from which novel products and processes emerge.
- *Innovation facilitation* – The enabling of innovation is often performed by innovation intermediaries, through financial support, networking capabilities, and mentoring/advice.
- *Policy-making* – Six types of government policies and regulation can influence the health of an innovation ecosystem: competition policy; trade policy; intellectual property; sector-specific regulations; good governance, transparency, and corruption; and public innovation platforms.
- *Demand* – This behaviour is a reflection of the needs and preferences of market customers, other end users, and governments.
- *Firm innovation* – This is the central behaviour of the innovation ecosystem with firms playing the principal role in translating ideas into innovation by using the resources of the ecosystem.

The state of the five aggregate behaviours governs the effectiveness of the innovation ecosystem in fostering and sustaining firm innovation, and ultimately generating impact. It follows that the state of the entire ecosystem, or regional and sectoral ecosystems, can be assessed by examining indicators of the five aggregate behaviours of the firm-centric innovation ecosystem. The firm-centric innovation ecosystem is an approach to assessment, rather than to measurement.

## EVALUATING THE ONTARIO INNOVATION ECOSYSTEM

Program impact measurements and indicators of aggregate behaviours can be combined to quantitatively evaluate the state of the innovation ecosystem. This involves developing a scorecard that organizes rigorous estimates of the returns to innovation investments at the program level by the ecosystem behaviour the program supports. Measurements and indicators can be compared over time or across jurisdictions. Developing an Ontario scorecard that fully reflects the Panel's firm-centric innovation ecosystem framework is currently not feasible because of insufficient data. Rigorous estimates of the impact of the suite of innovation support programs (six classes) have not been obtained according to the measurement approaches identified by the Panel. With the exception of knowledge generation,



**Figure 1**  
**The Firm-centric Innovation Ecosystem**

much of the data for indicators of the aggregate behaviours of the innovation ecosystem have not yet been collected. In fact, viable and agreed-upon indicators for policy-making and demand have not even been developed. Existing data only allow for the development of an incomplete scorecard; however, areas of Ontario strength in innovation and innovation support can be partially assessed by examining previously developed scorecards from other sources. In this sense, scorecards reside on a continuum, with the Panel's firm-centric innovation ecosystem approach as the best practice and previous scorecards as the best accomplished to date.

This largely quantitative approach may overlook contextual features of an innovation ecosystem and hide details of the interactions and feedbacks at the micro level. Quantitative analysis alone does not capture shifts in the mix, or expansions in the scope, of innovation investments and innovation policy. As such, more qualitative methods should complement quantitative approaches to innovation ecosystem assessment. Innovation case studies and surveys can be conducted of specific innovation actors (e.g., innovation intermediaries), economic sectors,

or entire ecosystems. Governments can use independent innovation investment and ecosystem evaluations to increase the effectiveness of the ecosystem by pinpointing bottlenecks and leverage points for innovation investments and policy to exploit. These evaluations, often conducted by blue ribbon panels of foreign experts, enable governments to monitor the state of the innovation ecosystem. Continually commissioning and updating evaluations of the impact of innovation investments and the state of the innovation ecosystem are standard practice in many leading innovation countries.

Applying the Panel's overall approach requires several commitments. First, to rigorously and reliably estimate program impact, according to the methodologies identified by the Panel, program evaluation would ideally be built directly into the design and delivery of innovation programs themselves. Second, more indicators of the five aggregate behaviours require collection, based on data from repeated cross-sectional observations and longitudinal data. This includes conducting benchmarking exercises of policy-making and demand. Third, the state of the Ontario innovation ecosystem could be constantly monitored by updating program impact measurements and commissioning independent innovation investment and ecosystem evaluations.

## **FINAL REFLECTIONS**

Although a formidable undertaking requiring significant resources, measuring the impact of innovation investments ensures that the most effective innovation programs are supported with secure, stable, and sufficient funding in the face of competing demands and austerity measures. Similarly, while assessing the state of the innovation ecosystem requires significant commitment, it is critical for pinpointing bottlenecks in the ecosystem that hinder innovation, and identifying leverage points to drive innovation. In general, innovation investment and policy are likely to be most effective as a long-term strategy if based on the most robust estimates of program impact and the most up-to-date and comprehensive picture of the entire ecosystem. With shifting economic and social circumstances, it is unlikely that governments can continue doing what they always have done in innovation investment and policy. Measurement and assessment enable the most effective innovation investments and efficient innovation policies. These investments and policies are, and will continue to be, critical for Ontario's economic and social progress.