5 More S&T Strategy Conundrums

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November 2013

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By popular demand, this paper is a follow-on to the original
(10 S&T Strategy Conundrums - http://impactg.com/index.php?headline=96).

Conundrum #11: Allocating public sector research investments

In our earlier paper (10 S&T Strategy Dilemmas, October 2013) we introduced the dilemma of whether and how the public sector should allocate research funding to and among existing and emerging fields of research. (For instance, the UK government is investing £60 million to a graphene technology development program. Canada is not.) The UK example illustrates the challenge of picking "technology winners" ... and by default, losers. But there is another set of investment allocation dilemmas facing governments; how to allocate resources among different research funders, different fields of research, and different research performers. Specifically:

- How much money to allocate among natural sciences, health sciences, social sciences and humanities research, and interdisciplinary research[1];
- How much to allocate to "basic" versus "applied" research[2] and,
- How much of the total to allocate among the higher education sector (universities and colleges), industry, government (non-regulatory), and not for profit research performers.

The fact is, nobody in government sits down prior to the start of the fiscal year and asks how much of total resources should be allocated to each research field or to basic versus applied research funding or the 4 main performing sectors - higher education, industry, government, not for profit. Allocations tend to be a combination of historical behaviour ("we've always funded X research at this level or to this performing sector") or impromptu decision making ("we've got a gap in X research, let's add some money").

So really, when it comes to publicly funded research we don't have a model or a mechanism for overall asset allocation. Should we have an asset allocation model and mechanism that is regularly or periodically updated? If we did, who would decide and how? Or, should we largely muddle along, as we do at present? What are your thoughts?

[1] i.e. To NSERC, SSHRC, CIHR, Tri-Councils.

[2] Paying due regard to the fuzzy nature of the distinctions.

Conundrum #12: University technology commercialization

A large portion of government research funding is directed to universities. Some is spent on so-called "basic" research and some to "applied" research. During the tech boom of the late 1990s expectations grew hugely that university research funding would yield vast commercialization benefits to the economy, let alone to individual institutions. (For a number of years government laboratories were also swept up in the wave of optimism and commercialization became *a cris du coeur* there too.) Promises were made by the university community that increased investments would produce a trebling of commercial outputs and outcomes - new products, services and companies - that would spur the economy. That never came to pass.

Yet history tells us that a small number of university-based discoveries and technologies can yield enormous, transformational benefits - transistors, insulin, and the like. So, it would be foolish not to invest in basic research because (the argument goes) we never know where the benefits will emerge from.

Consistently, the return to the universities themselves from commercialization of their research through royalties and licenses, has struggled to balance out the direct costs of commercialization. In a typical year the entire university research tech transfer system might generate a small surplus; that is, licensing income minus the direct costs to operate the institutions' tech transfer offices[3].

Furthermore, industry reports that universities lie low on its list of important sources of commercialization knowledge, typically ranking in 6th place, after a company's own staff, suppliers, competitors, vendors, etc.[4] This throws into question the entire "mind-to-market" paradigm in which universities are seen as the major driving source of new knowledge that leads to improved economic performance.

So, why the enormous focus on university research for commercialization? Is our optimism misplaced, are we expecting too much? Are there better ways of funding university research that will have commercial outcomes; for example, by giving the money to industry for demand-led university research? Should investment levels in basic or applied research be increased, decreased or maintained? Are there better ways of obtaining commercialization outcomes? Are our expectations simply too high? What are your views?

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[3]For example, in 2008 all institutions generated licensing and royalty revenues of $53.2 million against tech transfer costs of $51.1 million - a "profit" of $2.1 million.

[4]Cathy Read. *How do Innovative Manufacturing Establishments Acquire acquire knowledge and technology: Findings from the 2005 Survey of Innovation. Statistics Canada.* Innovation Analysis Bulletin — Vol. 9, no. 1 (May 2007)

Conundrum #13: Big universities vs. the rest

Canada's largest universities - the 19 members of Research Infosource Inc.'s "100 Million Club"[5] of universities that garnered at least $100 million in research income in 2012 - account for 87% of all research funding[6] (up from 86% the prior year). The other 31 universities on Infosource's Top 50 Research Universities list accounted for 23% of the total. The largest universities argue that they should be granted special status, and that governments should direct special funding toward them and their researchers, both to fund more research and to provide a higher proportion of their related overhead costs.

Yet if one looks at the situation of the smaller institutions, increased government research (and overhead funding) in the past decade has vastly improved their performance; for example in the amount of research they are conducting and in their publication outputs; albeit, from a smaller base.

So, should governments show special treatment to larger universities, or to smaller institutions, or maintain the status quo? Should it fund a special cadre of research universities and leave the others to focus on teaching? What do you think?

Conundrum #14: Mind the gaps

Talk to many policymakers and they'll tell you their objective is to "fill the gaps in the innovation system". The underlying assumption is that the innovation system is replete with "gaps" (e.g. early stage company funding gap, "valley of death", etc.) and that it is those gaps that prevent us from making socioeconomic progress. The proposition is that once all the relevant gaps have been "filled", that the innovation system will work optimally. Is that paradigm valid?

Presumably, gap-filling strategies work by first filling the largest gaps and then moving on to smaller and smaller gaps, until they are all eliminated. This is the definition of declining marginal returns; spending additional money to fill smaller gaps. Think about it this way. For less than $15,000 you can buy a car today that will transport you at 160 km/hr. But if you want to travel at twice that speed - 320 km/hr. - you might need to spend $150,000 - 10 times as much. Gap filling is a bit like that.

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[5]http://www.researchinfosource.com/pdf/Top%2050%20Univ%202013%20-%20Article%20Final%20Version.pdf

[6]In reality, the vast majority of research funds are awarded to individual researchers and research teams, and not to institutions.

In an innovation system that is replete with perceived "gaps", public sector intervention has few limits - there endless gaps to fill. But isn't gap-filling a bit like patching holes on a bicycle's inner tube? Eventually, if you patch enough holes you don't have an inner tube, you have a mesh of patches, each covering a smaller and smaller hole. You've lost the sense of the whole (pun intended).

An alternative approach might be to periodically develop entirely new paradigms - to reinvent problems and solutions - rather than fill smaller gaps. In the past half-century or so Canada has excelled at inventing (or reinventing) new and relevant innovation paradigms. In the 1970s we "invented" the national granting councils (NSERC, SSHRC, CIHR)[7]. In the 1980s we invented the Centres of Excellence paradigm. In the 1990s we invented the Canada Foundation for Innovation research infrastructure paradigm. In the 2000s we extended the CFI infrastructure paradigm to fund big science projects and refined the Centres of Excellence paradigm by establishing business-led and knowledge mobilization NCEs. (Since then we seem to have run out of gas.)

So, the dilemma for policymakers is to accept or reject the gap-filling paradigm and if deemed helpful, to periodically replace it with an inventive new paradigm.

Conundrum #15: Health Research - The third rail

Is Canada spending too much, too little, or just about the right amount on health research? Canadians are justly proud that the country is home to some of the world's leading medical and life sciences research and researchers. Canada funds and produces around 3-5% of the world's medical research, meaning that over 95% is funded by other countries. So, on balance, we can expect 95% of useful discoveries and applications to come from abroad.

The federal government alone spends well over $1 billion a year funding health research, mostly at universities[8]. Why? What is the underlying investment paradigm? When was the last time you were prescribed an invented-in-Canada prescription drug? When was the last time you purchased an invented-in-Canada medical device[9] ... or underwent an invented-in-Canada surgical procedure ... or genetic test?

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[7]Or possibly, we re-invented them from their origins at NRC and the Canada Council.

[8]Through the Canadian Institutes of Health Research (CIHR). This does not count federal departmental spending or provincial government spending.

[9]The cardiac pacemaker might be an exception. The pacemaker came out of research into "cold heart surgery" in the 1940s by Canadian surgeons Dr. Wilfred G. Bigelow and Dr. John C. Callaghan at the Banting Institute in Toronto. (Source: http://www.nrc-cnrc.gc.ca/eng/dimensions/issue7/pacemaker.html).

Certainly, training the next generation of researchers and clinicians is an obvious and acknowledged output of health research funding - as for most university research funding; it is in everyone's interest for our health professionals to interact with the latest research in their field in order to inform clinical practice.

Additionally, have to acknowledge that so far as health is concerned, nature is often not our friend, it is our enemy. For instance, infectious organisms are constantly evolving in such a way as to avoid and overcome our best defences, so constant vigilance - and constant investment in research - are needed, just to maintain the levels of health security we already enjoy. So that's obviously one reason for continued investment in health research. But that investment is no guarantee of Canadian success.

Beyond that, why else fund health research? The figures suggest that the chances of Canadian research making breakthroughs in solving the world's toughest health challenges - cancer, heart disease, respiratory disease - are quite small. Our potential for capitalizing economically on any discoveries - i.e. commercializing them - are smaller yet.

Health research and practice are the epitome of declining marginal returns. Firstly, civilization's most important advances in health and wellness have already been made; improvements in sanitation, nutrition, infection control and immunization have already eliminated humanity's worst scourges - at least in the developed world. So increasingly we are focussing on health problems that affect smaller and smaller numbers of people.

Leading causes of death, Canada

Leading causes of death	2009
Malignant neoplasms	1
Diseases of heart	2
Cerebrovascular diseases	3
Chronic lower respiratory diseases	4
Accidents (unintentional injuries)	5
Diabetes mellitus	6
Alzheimer's disease	7
Influenza and pneumonia	8
Intentional self-harm (suicide)	9
Nephritis, nephrotic syndrome	10

Source: CANSIM Table 102-0561

Secondly, most of the leading causes of death are the product of age; the longer one lives the higher the chances of contracting disease - any disease. So from here on eliminating the most

prevalent causes of death is primarily of benefit to more elderly folks, who at the point that help is required, are bound to die sooner rather than later. It is debatable, in many cases, whether extending life is equivalent to improving quality of life.

Why is health research funding the "third rail" (as in the electrified rail on a subway line)? It is because nobody wants to ask hard questions about health research. We are all potential beneficiaries or know someone who is. Health research is like motherhood; nobody wants to question its importance, or its implementation.

But should we be having a more frank and open discussion about the benefits, costs, outputs and outcomes of Canada's investment in health research? What is your view?

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