Institute for
Competitiveness & Prosperity

Reinventing innovation and commercialization policy in Ontario

The Institute for Competitiveness & Prosperity
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Institute for
Competitiveness & Prosperity

The Institute for Competitiveness & Prosperity is an independent not-for-profit organization established in 2001 to serve as the research arm of Ontario's Task Force on Competitiveness, Productivity & Economic Progress.

Working Papers published by the Institute are primarily intended to inform the work of the Task Force. In addition, they are designed to raise public awareness and stimulate debate on a range of issues related to competitiveness and prosperity.

The mandate of the Task Force, announced in the April 2001 Speech from the Throne, is to measure and monitor Ontario's competitiveness, productivity and economic progress compared to other provinces and US states and to report to the public on a regular basis. In the 2004 Budget, the Government asked the Task Force to incorporate innovation and commercialization issues into its mandate.

It is the aspiration of the Task Force to have a significant influence in increasing Ontario's competitiveness, productivity and capacity for innovation. The Task Force believes this will help ensure continued success in the creation of good jobs, increased prosperity, and a high quality of life for all Ontarians. The Task Force seeks breakthrough findings from their research and proposes significant innovations in public policy to stimulate businesses, governments and educational institutions to take action.

The Task Force published its First Annual Report to the people of Ontario, C*losing the prosperity gap*, in November 2002. The Second Annual Report, *Investing for prosperity*, was published in November 2003.

Comments on this Working Paper are welcome and should be directed to the Institute for Competitiveness & Prosperity. The Institute for Competitiveness & Prosperity is funded by the Government of Ontario through the Ministry of Economic, Development, and Trade.

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Reinventing innovation and commercialization policy in Ontario

In its recent budget, the Ontario Government indicated its interest in strengthening innovation and commercialization in the province. It asked the Task Force on Competitiveness, Prosperity and Economic Progress to incorporate these issues into its work. To that end, the Institute for Competitiveness & Prosperity has focused this sixth Working Paper in this area.

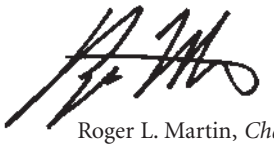
Our research indicates that the provincial and federal governments are correct in identifying innovation as an important priority for public policy. In Ontario, we lag our peer group of US states in producing patents – a general measure of innovation success – in our clusters of traded industries. But our work also suggests that for government policies and programs to have a greater impact, policy makers need to reinvent how they approach the issue by using a more robust model, one that better explains how the various factors in the innovation and commercialization process interact in our research institutions and businesses. A more robust model will also help to give policy makers a more thorough understanding of what the current data are saying.

As we assess policies at the provincial and federal levels, we find a bias toward a "supply side" or "support" model – with an over emphasis on the hard sciences and traditional R&D. In effect, the policies indicate a belief that the real challenge we have in Ontario and Canada is in having enough technical people, technology spending, R&D tax incentives, and the like. Our research indicates that these factors are only part of the challenge and as long as the model in the minds of policy makers continues to be narrow and incomplete, our province will make little progress on innovation and commercialization.

Sound economic policy requires close attention to what the data tell us about the broad innovation environment. For example, we find that our universities already are graduating more students per capita in science and engineering than our peer group. This suggests that public programs to increase undergraduate science and engineering students are not what we really need. Instead, our challenge is to raise the number of graduate degrees conferred and to increase the expertise of those in key professions – where we trail the peer states' performance. Similarly, we do not appear to lack venture capital funding in Canada. Again our challenge is to improve the quality of investment funding, not simply increase the quantity of funding.

In Working Paper 5, we introduced a model that integrates the factors that lead firms to develop and market innovations. Instead of a public policy focus on a narrow set of supply factors, we argue that innovation and commercialization policies need to encompass the full range of support factors, as well as the factors related to competitive pressure. This will help Ontarians identify opportunities to strengthen our market structures to provide greater specialized support and more intense pressure for our firms and industries. Such initiatives will contribute to greater innovation and to closing the prosperity gap with US peer states. We look forward to discussing this framework with stakeholders in Ontario's prosperity and have set out research areas that we intend to pursue.

We gratefully acknowledge funding support from the Ontario Ministry of Economic Development and Trade and collaborative support from the Institute for Strategy and Competitiveness, Harvard Business School.



Roger L. Martin, *Chairman*
Institute for Competitiveness & Prosperity

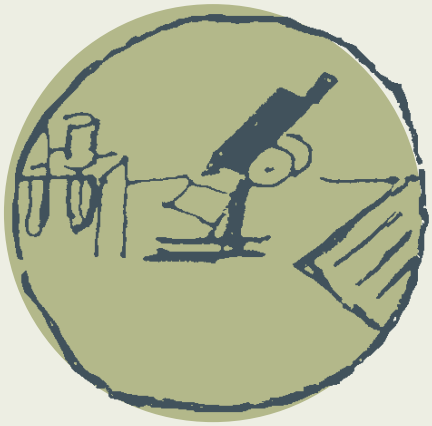
Executive summary

Reinventing innovation and commercialization policy in Ontario

Over the past two years, The Institute for Competitiveness & Prosperity has been exploring opportunities for strengthening Ontario's competitiveness and prosperity. We have identified a significant prosperity gap with a peer group of large US states and have concluded that this gap stems from lower productivity. Ontarians are not adding equivalent value to the human, natural, and physical resources in the province.

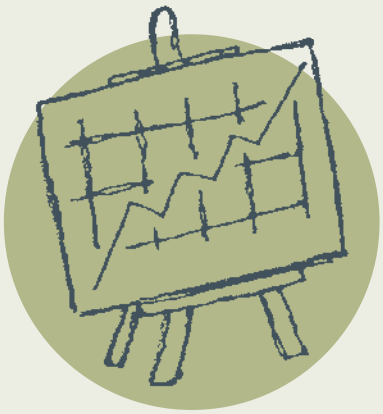
To guide our efforts, we developed the AIMS framework which highlights four factors that drive our capacity for innovation and upgrading:

- **Attitudes** towards competitiveness, growth, creativity, and global excellence
- **Investments** in human and physical capital
- **Motivations** for hiring, working and upgrading as a result of tax policies and government policies and programs
- **Structures** of markets and institutions that encourage and assist upgrading and innovation.



We have concluded that Ontarians are under investing for productivity, innovation, and prosperity. The demotivating impact of high marginal effective tax burdens on capital investment is a factor in this under investment. On a more positive side, attitudes towards risk taking, innovation, and competitiveness do not seem to differ significantly from those in the peer states. However, structures in our economy lack adequate specialized support and intense competitive pressure. This Working Paper continues our work in structures by directly tackling issues that effect innovation and commercialization.

Innovation has been an important part of the economic agenda of both federal and provincial governments; the commercialization of publicly funded research has more recently been added to this agenda. Our review of the evidence, including our previous work, indicates that the public policy focus on innovation and commercialization is well founded. Our most recent research shows that Ontario's traded clusters are less effective than their counterparts in the peer states in generating patents, a key measure of innovative capacity. In fact, per employee, Ontario's traded clusters produce 55 percent fewer patents than the median of our peer states. The World Economic Forum's National



Innovative Capacity Index serves as a broad indicator of a country's potential to create commercially relevant innovations. It indicates that Canada's most significant gap is in the area of company operations and strategy. Our firms tend less to rely on innovation to develop competitive advantage than those in other large economies.

Complex public policies, such as innovation and commercialization, require a robust and balanced model for addressing the complicated and interrelated issues they present. A model simplifies the many details and interactions that occur in the real world with enough accuracy to help policy makers think through logically the impact of various initiatives under consideration. We think the Institute's model of "support" and "pressure" developed in our last Working Paper is a robust one that can help assess current policies and point to areas of priority. As we assess current policies, we conclude that they are based on an inadequate model that focuses almost exclusively on a narrow set of support measures.

Current government policies and investments treat innovation as a narrow support problem

Public policy makers in Canada and Ontario seem to be acting on a traditional supply/demand model and have concluded that enhanced supply factors are the key challenge for strengthening innovation. The logic starts with a narrow definition of innovation focused on scientific or technological breakthroughs versus business practice innovation. From this premise flows the conclusion that our innovation problem is the result of an inadequate supply of scientific and technical labour, funds for R&D, and funds for commercialization. Our review of government programs at the federal and Ontario levels leads us to conclude that they are narrowly defined around increasing the supply of scientific and technical R&D and personnel. However, the data point to the importance of other non-technical kinds of support, as well as pressure factors to stimulate innovation and commercialization.

Evidence indicates that the innovation gap is not a support problem, but rather an issue of under performance.

As we assess the data related to **R&D** investment, the availability of science and engineering personnel, and the supply of venture capital funds we conclude that public policy is not as grounded in the evidence as it needs to be.

The quantity of Ontario's R&D is less of a problem than its composition. While we have been close to, or at, the peer group median in total R&D spending as a percentage of GDP, we have trailed in business R&D and have outspent our peers in performing R&D in publicly funded institutions. In business expenditure on R&D as a percentage of GDP, the most important type of research and development, Ontario consistently trailed peer states through the 1990s. However, we have been closing this gap. As of 2000, Ontario was above the median of its peers. In the area of R&D conducted by higher education as a percentage of GDP, Ontario was ahead of all other jurisdictions except for Quebec in 2000 (the latest year for which we have comparative results); through the 1990s Ontario stood third, behind Quebec and Massachusetts. Government expenditure is a small component of R&D overall and Ontario's performance is close to the median level.

Our review of the evidence with respect to **scientific and engineering personnel,** indicates that the challenge we have in Ontario is quality, not quantity. Ontario has a slightly higher stock of science and engineering graduates in its population than does the US and we have had this overall advantage since the mid-1990s or earlier. And in the flow of new graduates, we continue to outpace the US. But Ontario's advantage is only among those with bachelor's degrees. In both the stock and flow of science and engineering graduates, we trail the US in graduate degrees. In other words, we lead in the overall quantity, but lag in the quality of this human capital investment. Programs, such as Ontario's Access to Opportunities (ATOP) which was developed to increase the quantity of undergraduates in science and engineering, addressed a situation that was not then or now a problem.

In **venture capital,** the evidence indicates that the availability of funds in Ontario is similar to that in the peer states. To be sure, Ontario is well behind the amount of venture capital raised and invested in California and Massachusetts. These two states dominate the US in venture capital, accounting for 40 percent of the investment despite having only 16 percent of GDP. It is unclear whether or not Ontario can or should aspire to match the level of venture capital in these two states. Some argue that since Ontario is Canada's leader, it should aspire to match the US leaders. In our view, since Ontario trails peer states more significantly in other areas, such as tax burdens and post-secondary education, the level of venture capital is not a priority. In any event, current public policy indicates a belief that venture capital represents a supply problem – we have inadequate venture funds. However, we interpret the evidence to point to issues of quality not quantity for two reasons. First, the amount of venture capital raised has surpassed the amount of funds invested in Canada in recent years. Secondly, investment returns in Canada have been much lower than in the US. Public policy initiatives such as labour sponsored investment funds and new funding for venture capital by governments are not useful. Our challenge in Ontario is creating market structures that drive more high quality investment opportunities, not a greater quantity of venture capital.

In summary, the evidence indicates that current public policy is narrowly aimed at strengthening support for science and technology, often in areas where support is not required. Innovation and commercialization policies need to be aimed at a broader range of support and in strengthening competitive pressure.

Public policy needs to be informed by a fuller definition of support and by competitive pressure

Broader and deeper support for innovation and commercialization is critical. Our model of pressure and support recognizes the importance of science and engineering personnel. But how do we focus public policy to get the right number of engineers and scientists with the right skills? We recognize the critical importance of higher education R&D funding; but how can we strengthen industry-university collaboration? And venture capital is very important to innovation, competitiveness, and prosperity. But how can public policy drive towards more high quality investment opportunities and greater returns?

Specialized support factors, such as the quality of management and management schools are overlooked. The evidence indicates that Ontario managers are less well educated than their US counterparts, in general and in business education. Fewer of our managers have university degrees of any kind and particularly degrees in business. The CEOs of our largest public corporations are less likely to have MBAs than their US counterparts. It is hard to ignore this gap in human capital in light of our under performance in competitiveness and innovation and in our relatively poor rankings in company operations and strategies as found by the World Economic Forum.

Pressure for higher competitive intensity will spur business innovation. Complementing specialized support is the stimulation of demand for innovation and commercialization that comes from intense rivalry among firms and the sophistication of customers. Both of these pressure factors are problematic in Ontario and Canada. A key element of enhancing pressure for innovation is the presence of sophisticated business strategies and operations. Businesses that depend on innovation for survival and success will demand greater innovation in their own firms and from others such as universities and research institutes. If we really want to solve the commercialization challenge, we must create a higher demand for innovation. To do this, we must look at the competitive pressures that face our leading companies and what can be done to encourage businesses to be more competitive in the marketplace.

Creating an environment in which Ontario businesses *can* and *must* innovate and commercialize is the key public policy challenge. Both require attention. Clear answers and policies can help close the innovation – and in turn the prosperity – gap with high-performing peer states.

Ideally, governments and businesses will implement a robust model to develop integrated initiatives to create support and competitive pressure for innovation and commercialization.

As the Institute begins its exploration of the challenges and opportunities in innovation and commercialization, we have used the framework of support and pressure we have developed to identify the key issues for our research and to guide our analysis. We have developed a challenging research agenda.

In summary, focusing on providing the support and pressure factors identified in our model will help drive more innovation and commercialization in Ontario. To get the right factors in the right place, policy makers need to reinvent how they think about the challenge. From a focus on a narrow set of support factors, they need to broaden and deepen their objectives and implement programs to encourage more specialized support and intensify competitive pressure in both the public and private sectors. Business leaders, as well as scientists have major roles to play in contributing to upgrading our environment for innovation in Ontario to close the productivity gap and raise the prosperity of all Ontarians.

Reinventing innovation and commercialization policy in Ontario

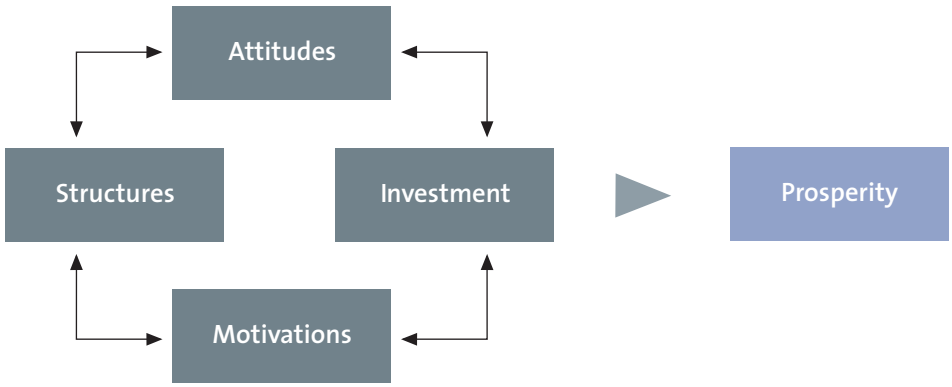
Ontario needs a comprehensive approach to innovation and commercialization

Since its inception in 2001, the Institute for Competitiveness & Prosperity has been exploring opportunities for strengthening Ontario's competitiveness and prosperity. In our work, we have been comparing Ontario's productivity with that in peer states and found that we have a significant prosperity gap with those similar US regions. This prosperity gap indicates that Ontarians are not adding equivalent value to the human, natural, and physical resources in the province.

To guide our efforts in analyzing the causes of our prosperity gap, we developed the AIMS framework (Exhibit 1), which highlights four factors that drive our capacity for innovation and upgrading:

- **Attitudes** towards competitiveness, growth, creativity, and global excellence
- **Investments** in human and physical capital
- **Motivations** for hiring, working and upgrading as a result of tax policies and government policies and programs
- **Structures** of markets and institutions that encourage and assist upgrading and innovation.

Exhibit 1 AIMS builds capacity for innovation and upgrading



Source: Institute for Competitiveness & Prosperity

As the Institute noted in Working Paper 5, "Ontarians need to strengthen our capacity for innovation and upgrading to raise our productivity each year until we catch up to our peers."[1] By achieving this target, we can significantly improve Ontarians' economic well-being, as well as increase the capacity for public expenditures in health care, education, and social services.

In our previous work, we identified Ontario's chronic under **investment** in physical and human capital as a key contributor to the gap. We also observed that the high marginal effective tax burden in the province lowers **motivations** for Ontarians to innovate and upgrade. On a more positive side, **attitudes** do not seem to be significantly different than those in our peer states on issues such as competitiveness, risk taking and innovation.

In Working Paper 5, our research focused on **structures** in our economy and their role in enhancing Ontario's prosperity. From that work, we concluded that:

- Ontario's clusters under perform
- Ontario's market structures lack adequate specialized support and intense competitive pressure
- Stronger structures would raise our capacity for innovation and upgrading.

This Working Paper continues our work on structures by directly tackling issues that effect innovation and commercialization in Ontario. Specifically, we are interested in understanding the factors that can motivate us to be more innovative, to invest more in research and development, and to commercialize more of the scientific and technical work from our universities and research centres. On the flip side, we are just as curious about what detracts

[1] Institute for Competitiveness & Prosperity, *Strengthening structures: Upgrading specialized support and competitive pressure*, p. 7

us from developing innovative products and taking them to market. To begin, we see that Ontario is not keeping up with our peer states and to address this problem we need to reinvent how policy makers think about innovation and commercialization policy.

Innovation and commercialization come up short

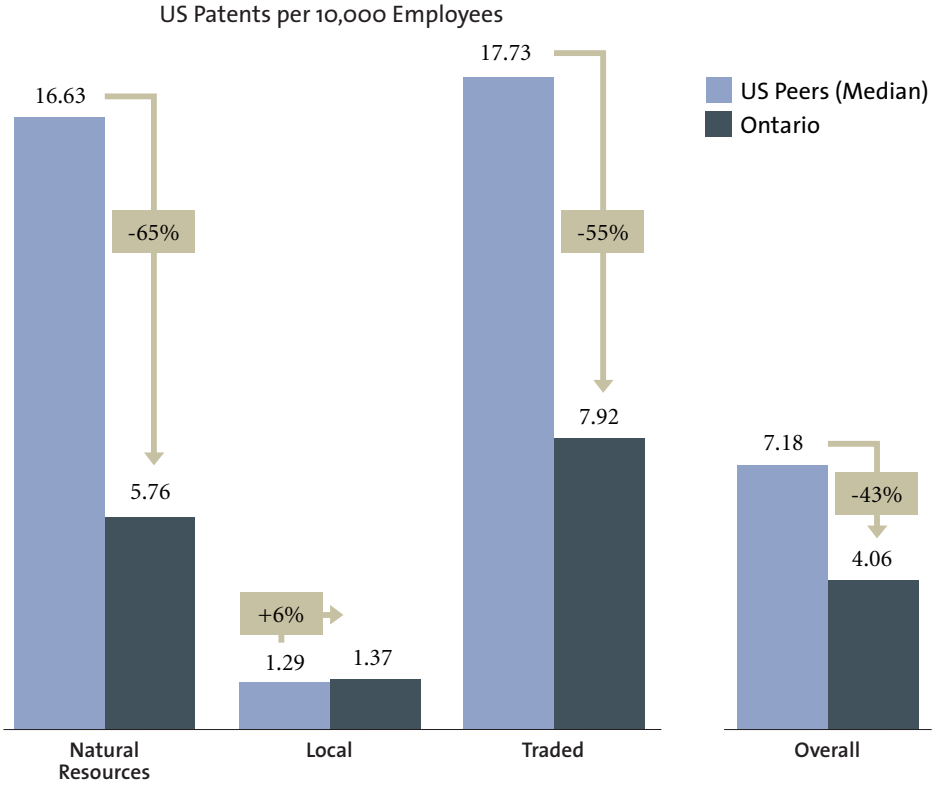
Over the last few years, both the federal and provincial governments, as well as several independent think tanks, have intensified their efforts to improve *innovation* in Canada and in Ontario, resulting in significant new investments in R&D support across our economy. In February 2002, the federal government launched Canada's Innovation Strategy, highlighting goals, milestones and targets to raise the level of innovation in this country. One of the key goals of this initiative was to "rank among the top five countries in the world in terms of research and development (R&D) performance by 2010."[2] The Ontario provincial government has also recognized the importance of innovation. In the recent budget it stated, "Investments in innovation – including research and development – are catalysts for industry to make better use of economic resources, setting the stage for the next generation of economic growth in Ontario."[3] Hon. Joseph Cordiano, Minister of Economic Development and Trade stated, "…we're preparing Ontario to lead in both knowledge and innovation. The… government knows that information, invention, and innovation are the new pillars of economic strength and success that create more wealth, increase our prosperity, and achieve a standard of living that is second to none."[4] At the same time, the Conference Board and numerous other organizations have also developed various "innovation strategies."

Recognizing this challenge, the federal and Ontario governments have more recently added the dimension of *commercialization* to their innovation strategies. Not only must we generate more research, but we must also ensure that the new developments enter the economy in a way that will increase our productivity and benefit all of us.

At the federal level, the 2004 Speech from the Throne highlighted how "the Government of Canada has helped lay the foundation for even greater success with very substantial investments in basic research — $13 billion since 1997. … Now we must do much more to ensure that our knowledge investment is converted to commercial success. We need to do more to get our ideas and innovations out of our minds and into the marketplace."[5] The federal government has also recently appointed National Science Advisor Art Carty in a new role to lead the National Research Council to seek ways to accelerate technology transfer and to support new spinoff companies.

In Ontario, the recent Budget[6] identified "the commercialization of ideas derived from R&D performed in Ontario" as a major challenge for 2004 and the years ahead. The government vowed to "expand the focus on its innovation programs to enhance commercialization in Ontario's public research institutions."

Exhibit 2 Ontario trails peer states in patent output, especially in traded industries



Source: Institute for Competitiveness & Prosperity, Institute for Strategy and Competitiveness, Statistics Canada, patent data from US Patent and Trademark Office, CHI Research
Note: Ontario results: 1999-2003 average. US results: 1997-2001 average.

[2] Government of Canada, *Achieving Excellence*, January 2001, p. 51
[3] Ontario Ministry of Finance (2004), *2004 Ontario Budget: Budget Papers*, Paper B, p. 103
[4] Speech to Economic Club of Toronto, June 24, 2004
[5] Speech From The Throne, February 2, 2004; http://pm.gc.ca/eng/sft-ddt.asp
[6] *2004 Ontario Budget: Budget Papers,* Paper B, p. 105

Our review of the evidence indicates that the public policy focus on innovation and commercialization is well founded. Our previous research indicates that our capacity for innovation and upgrading is weaker than the capacity in our peer states and needs to be strengthened. Our most recent research into our clusters' patent output and survey evidence from the World Economic Forum further supports this need. But to develop responsive public policies in innovation and commercialization, a robust model is required – the support/pressure model developed in our last Working Paper meets this need. We discuss each in turn.

Patents lag US leaders

A key measure of innovative capacity and processes is patenting. While it is important to note that not all innovative activity is captured by patents (e.g., in management process improvements or in software), many academics who study innovation agree that patenting is a solid measure of a nation's or region's innovative output.[7]

A patent grants exclusive commercial use of a newly invented device. According to Trajtenberg, "For a patent to be granted, the innovation must be non-trivial, meaning that it would not appear obvious to a skilled practitioner of the relevant technology, and it must be useful, meaning that it has potential commercial value."[8]

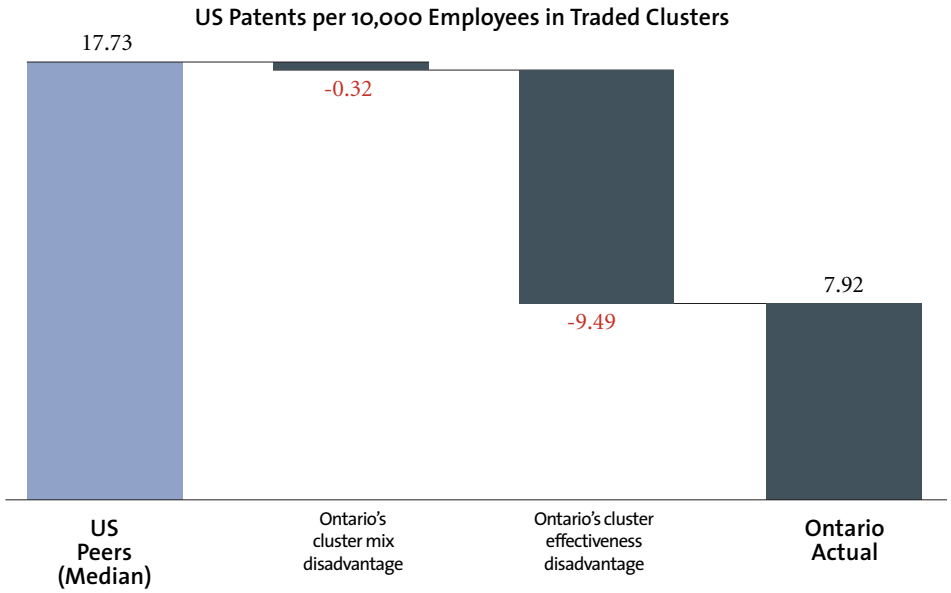
To measure Ontario's innovative capacity, we gathered information on patents by Canadians at the US Patent and Trademark Office. US patent information is a good indicator for Canadians because "patents are often sought first and foremost in the US where the standards for patentability are more stringent than in most European countries."[9] In addition, because of its size and economic strength, the US market represents a significant potential market for a typical patent.

To measure patent output in Ontario, we compiled patent records where a Canadian inventor was named.[10] We sorted patents by year of issue, province, Census Metropolitan Area, and industry. Our industry classification was based on the traded/local/natural resource distinctions we have used in our work to date. Within the traded industries, we assigned patents to one of 41 traded clusters consistent with the methodology we have adapted from Michael Porter's Institute for Strategy and Competitiveness[11] and used in our previous research.

As in the peer states, Ontario's traded industries are more innovative than local industries because they are more specialized and face greater competitive pressure from a wider set of competitors and customers. However, at 7.92 patents per 10,000 employees, our traded industries trail the median performance of our US peers by 55 percent (Exhibit 2). We also trail in natural resource industries and have a small advantage in local industries which tend to produce very few patents per employee.

As we have observed with the wage and productivity performance of our traded clusters,[12] Ontario has a good mix of traded clusters but they are less effective in achieving innovation output. Our mix of clusters is such that if they matched US patent results, Ontario would be only 2 percent behind the peer states. Instead, we trail by 55 percent per employee – nearly all of this disadvantage (53 percent of the 55 percent) is because of lower effectiveness (Exhibit 3). In all but six of the clusters, Ontario's patent output per employee is behind peer state output (Exhibit 4).

Exhibit 3 Ontario clusters trail US peers in patent output largely because of effectiveness



Source: Institute for Competitiveness & Prosperity, Institute for Strategy and Competitiveness, Statistics Canada, US Patent and Trademark Office, CHI Research
Note: Ontario results: 1999-2003 average. US results: 1997-2001 average.

[7] See Michael Porter, "The Economic Performance of Regions", *Regional Studies*, Vol. 37, 66 &7, p. 551 and note 9, p. 572 for a review of the academic work in using patents as a measure of innovative capacity.
[8] Manuel Trajtenberg, "Is Canada Missing the 'Technology Boat'?" Centre for the Study of Living Standards, 1999, p. 5
[9] *Ibid.*, p.4
[10] US Patent and Trademark Office data compiled for the Institute by CHI Research
[11] See *Strengthening structures: Upgrading specialized support and competitive pressure*, July 2004 p. 24 for a discussion of traded clusters. Visit www.isc.hbs.edu for more information and US results
[12] *Strengthening structures*, pp. 24-26

Exhibit 4 Ontario trails peer state patent performance in nearly all clusters

Traded Clusters (Ontario employment rank) ☐ TOP TEN ONTARIO EMPLOYMENT	US PATENTS PER 10,000 EMPLOYEES		Ontario / Peer States
	Ontario[a]	Peer State Median[b]	
Jewelry and Precious Metals (35)	5.12	2.24	2.29
Business Services (1)	0.59	0.28	2.08
Agricultural Products (23)	9.60	7.97	1.20
Sporting, Recreational and Children's Goods (37)	46.57	39.28	1.19
Transportation and Logistics (7)	0.95	0.83	1.15
Prefabricated Enclosures (31)	16.16	15.18	1.06
Hospitality and Tourism (5)	1.05	1.09	0.97
Distribution Services (9)	0.23	0.27	0.88
Heavy Construction Services (8)	4.50	5.36	0.84
Entertainment (12)	10.51	13.23	0.79
Communications Equipment (20)	93.31	118.29	0.79
Building Fixtures, Equipment and Services (13)	11.97	15.52	0.77
Aerospace Engines (38)	9.42	12.54	0.75
Tobacco (39)	12.88	19.10	0.67
Fishing and Fishing Products (40)	21.97	32.70	0.67
Power Generation and Transmission (22)	10.50	15.75	0.67
Plastics (17)	28.10	44.71	0.63
Processed Food (11)	4.64	7.52	0.62
Financial Services (2)	0.03	0.05	0.61
Leather and Related Products (36)	19.56	35.16	0.56
Education and Knowledge Creation (3)	0.77	1.44	0.54
Construction Materials (34)	18.24	35.21	0.52
Furniture (25)	4.77	9.57	0.50
Apparel (19)	2.61	5.36	0.49
Motor Driven Products (27)	30.98	64.45	0.48
Medical Devices (28)	48.61	101.59	0.48
Lighting and Electrical Equipment (32)	16.29	34.06	0.48
Production Technology (14)	27.35	58.63	0.47
Information Technology (15)	43.47	93.99	0.46
Weighted Average	7.92	17.73	0.45
Footwear (41)	19.05	45.13	0.42
Biopharmaceuticals (30)	35.48	97.46	0.36
Aerospace Vehicles and Defense (33)	11.51	32.73	0.35
Metal Manufacturing (6)	7.43	21.28	0.35
Publishing and Printing (10)	5.03	14.55	0.35
Chemical Products (21)	25.50	73.99	0.34
Oil and Gas Products and Services (20)	15.25	44.37	0.34
Analytical Instruments (24)	46.24	137.25	0.34
Heavy Machinery (18)	11.59	40.05	0.29
Textiles (29)	9.19	37.36	0.25
Automotive (4)	9.93	48.77	0.20
Forest Products (16)	4.51	25.85	0.17

[a] Ontario results: 1999–2003 average; [b] US results: 1997–2001 average
Source: Institute for Competitiveness & Prosperity, Institute for Strategy and Competitiveness, Statistics Canada, US Patent and Trademark Office, CHI Research

To help explain differences in national innovative output, such as patents, the World Economic Forum has created the National Innovative Capacity Index. We review the findings from their index in the next section.

Canada trails on the national innovative capacity index

The national innovative capacity index (NICI) was developed by the World Economic Forum[13] as a broad indicator of a country's potential to create commercially relevant innovations. The index assesses various dimensions of the national capacity for innovation, weighted according to their observed statistical relationship with international patenting.

The NICI, is found to have a strong and positive relationship with GDP per capita, the measure of prosperity adopted by the Institute. It is also positively correlated with the Business Competitiveness Index.[14] In 2003, Canada ranked 12th among 78 countries on the NICI, a drop from 9th in 2002. Among the 43 countries with half of Canada's population or more[15], Canada ranked 7th in 2003 falling from 5th in 2002 while the US has maintained its top position on the index. Among the larger countries, Canada in fact ranks second in GDP per capita. Our lower rank in NICI indicates our under performance in innovation capacity given the underlying competitiveness of our economy. The NICI is the sum of five sub-indices: the innovation policy index, the proportion of scientists and engineers index, the cluster innovation environment index, the innovation linkages index and the operations and strategy index.

Canada ranks well behind the US on the overall NICI index – fully 9.5 percent or more than two standard deviations behind US

[13] Michael Porter and Scott Stern, "Ranking National Innovative Capacity: Findings from the National Innovative Capacity Index", WEF, *The Global Competitiveness Report 2003-2004*, 2004, p. 91
[14] For a discussion of the WEF's Business Competitiveness Index, see *Strengthening Structures*, p.38
[15] We compare Canada's performance against countries with half of Canada's population or more to focus on economies with similar breadth and complexity.

performance.[16] This gap is driven largely by our poor performance on the company operations and strategy sub-index and, to a lesser extent, the innovations linkages sub-index. Canada trails the US less significantly on the other three sub-indices.

Canada nearly matches the US on the innovation policy sub-index

This is a measure of the effects of government policies, such as R&D incentives and intellectual property protection, on the innovation environment. Canada scores higher than the average of the top twenty countries in the innovation policy index, ranking 4th among the larger countries. Of all the sub-indices, Canada ranks closest to the US on the innovation policy sub-index (Exhibit 5). This sub-index has the lowest variance among the top twenty countries of any of the sub-indices. This is likely a result of the limitations of public policy in stimulating innovation once a certain level has been reached. It may also reflect the tendency of countries with advanced economics to borrow successful policies from their peers.

Canada trails slightly on the proportion of scientists and engineers sub-index

This is the share of total employment made up by scientists and engineers – the one empirical measure used in the NICI. This index provides a measure of the availability and effect of the R&D labour force on innovation. Among larger countries, Canada ranks 5th on this index and the US ranks 2nd after Japan.

Canada's position is also slightly behind on the cluster innovation environment sub-index

This measures the quality of a nation's economic clusters and its effect on innovative output. Canada scores above the average of the top twenty countries on this index. Among larger countries, Canada ranks 5th trailing Japan (1st), the US, Germany, and Taiwan.

Canada trails on the innovation linkages sub-index

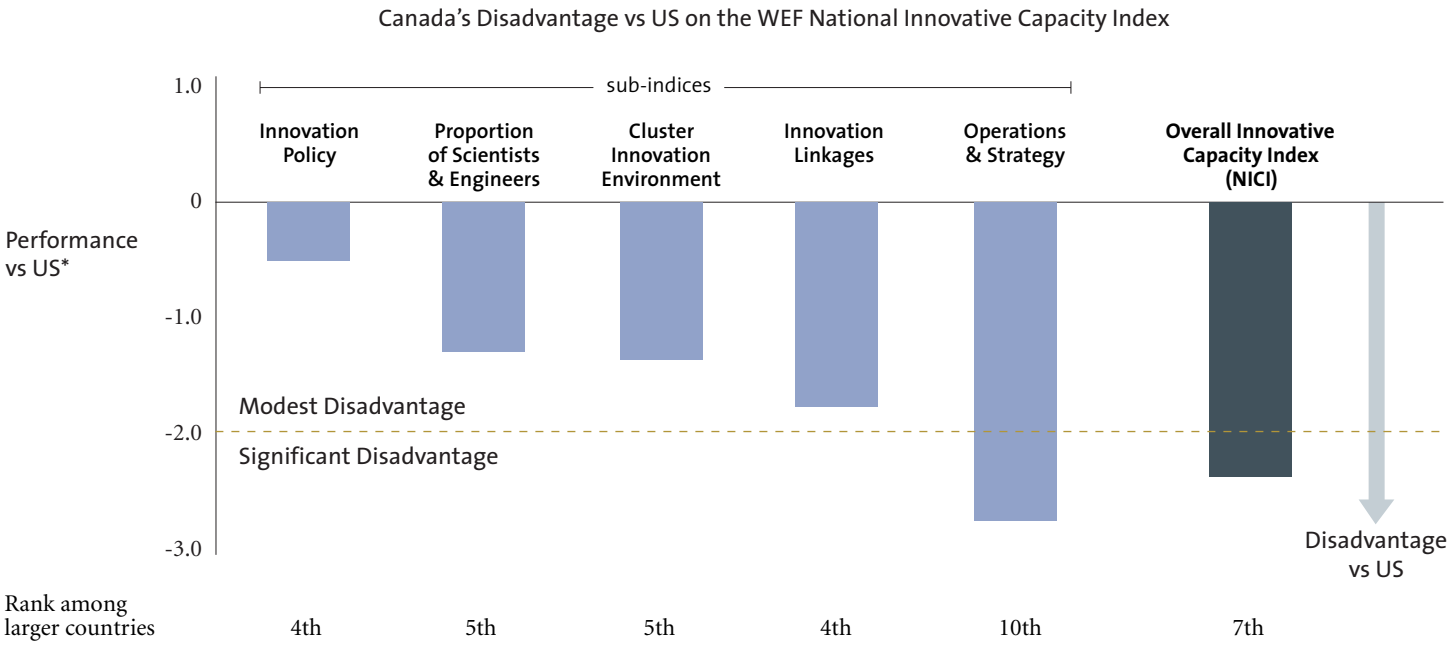
This is a measure of the strength of the connections between a nation's innovation infrastructure (e.g., universities and private and public institutions) and its clusters. This includes the availability of research associations and venture capital for risky projects. Although Canada scores well on the innovation linkages index, ranking 4th among larger countries, it falls significantly behind the US, the top country.

Canada lags most larger nations on the operations and strategy sub-index

This index measures the degree to which a nation's firms find competitive advantage through innovation rather than other strate-

[16] The standard deviation measures how dispersed the scores for the top twenty countries are from the average of these top twenty. The larger the standard deviation, the more spread out the scores are from the average. About two thirds of the group is within one standard deviation of the average; 95 percent are within two standard deviations; 99 percent are within three.

Exhibit 5 Canada lags US innovative capacity largely because of company operations and strategy



* in standard deviations from the average scores of the top twenty countries
Source: Institute for Competitiveness & Prosperity based on World Economic Forum

gies. For the top twenty countries, the operations and strategy index has the highest degree of variance, an indication of its importance to the overall score. Canada scores significantly below the average of the top twenty countries on this index, trailing by more than one standard deviation. Compared to the US, which ranks first in operations and strategy, Canada trails by more than two standard deviations. Among the larger countries, Canada ranks 10th in company operations and strategy.

Ontario needs to reinvent its approach to innovation and commercialization

Complex problems require a robust and balanced model for addressing the complicated and interrelated issues they present. Policy issues related to innovation and commercialization in Canada are no different. A model sets out the key outcomes required from innovation, identifies the inputs that drive these outputs, and describes the process of how the inputs interact with each other to drive successful outcomes. A model simplifies myriad details and interactions that occur in the real world so that these can be analyzed effectively and efficiently. A robust model, that describes the real world with enough accuracy, helps policy makers to think through logically the potential impact of various policy initiatives and programs in achieving the desired outcomes. Two examples of the importance of robust models highlight how models are used.

Scientists use models to address the challenges of climate change

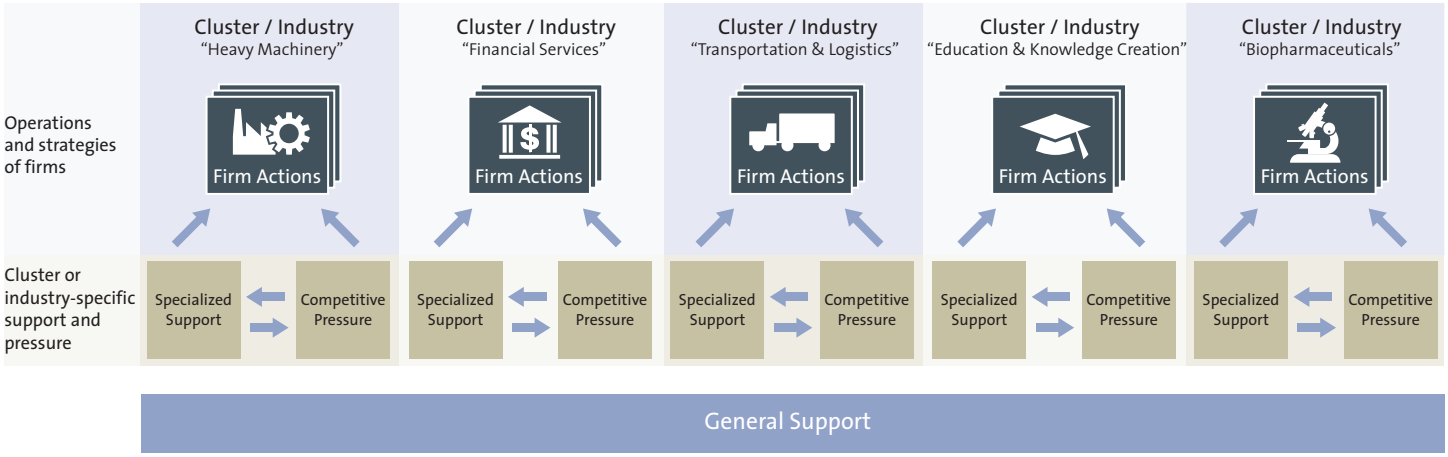
Scientists are trying to determine whether or not higher temperatures will occur over the coming decades and centuries and what are the factors that affect this. For some, their model says human, industrial and other activity creates greenhouse gases thereby gradually raising the temperature. People who disagree with this model may argue that outcomes have not been tracked correctly. Or they may argue against the relationship between human activity and greenhouse gases. In the final analysis, the model will be robust if it can predict outcomes, identify the key inputs, and how they interact.

Economists depend on supply and demand models

Economists have developed a workable model to explain the direction of prices and quantities sold of a given item. The key inputs to these outcomes are categorized as either supply or demand factors. Supply factors focus on what it takes to produce goods or services and provide them to customers. These include the costs of production, the availability of plentiful raw materials, and the ease of purchasing items through high-capability logistics processes. Demand factors focus on the consumer of the goods or services in question. They include the importance that consumers attach to owning or consuming the items, the amount of disposable income they have to spend on specific goods, and the convenience in purchasing these goods. The model indicates that as supply increases, prices tend to fall and as demand increases, prices tend to rise.

But the real insight by economists is that both supply and demand need to be considered in understanding prices and quantities. Policy makers must understand the nature of supply and demand in a specific market before designing economic strategies. If too much emphasis is given to supply factors, without stimulating demand, prices will fall; and depending on the demand pattern, the quantity demanded may not increase. This model applies to prices and quantities of goods and services, including investments. As John Maynard Keynes pointed out, if governments focus on increasing the supply of funds for business investment, but business leaders are

Exhibit 6 Structure of pressure and support drives quality of firm actions



not willing to invest, the only impact will be lower interest rates, but not higher investing activity – others have likened this to pushing on a string.

Integrating "support" and "pressure" policies encourages more innovation

Certainly, the federal and provincial governments are now motivated to improve the innovation and commercialization results in Canada and Ontario and are making significant investments in the area. Nevertheless, we argue that governments need a more robust model that explains how innovation and commercialization happen and helps develop more effective policies to improve outcomes. That approach needs to consider the structures in the economy that create the specialized support and competitive pressure to drive innovation and higher productivity that are now under performing.

The Institute's model encompasses broad support and pressure factors that drive firm actions. Support is both *general*, including physical infrastructure and primary and secondary education, and *specialized* with focused research and well-developed linkages among academic institutions and businesses. Competitive pressure is the result of the combination of intense rivalry and sophisticated customer demand (Exhibit 6).

The important *general support* factors include the:

- Quality of the educational system, including the quality of public schools and the quality of math and science education
- Administrative environment for start-ups, including reliable social services, legal, judicial, and administrative services, and supportive macroeconomic conditions.

The important factors related to *specialized support* include the:

- Availability of scientists and engineers who create new knowledge or adapt existing knowledge
- Funding for R&D that results in patents, high-quality scientific research institutions, and university/industry research collaboration
- Sources of debt and equity financing, including access to loans, venture capital, local equity markets for innovative business start-ups and their subsequent development
- High-quality business programs that graduate capable business leaders who identify innovation as a key element in creating competitive advantage.

The important factors related to *competitive pressure* that force businesses to seek out opportunities for innovation include:

- Sophistication of local buyers
- Intensity of local competition, partly driven by the extent of locally based competitors.

In Working Paper 5, we reviewed how these factors work together to drive successful clusters and global competitiveness:

> "…the research strongly reinforces the reality that an environment featuring a combination of support and pressure is most beneficial in nurturing and growing competitive global companies…. The presence of… powerful elements of support tend to attract multiple competitors, which helps create an important element of pressure, which is the rivalry among co-located firms. Rivalry among alternative firms helps customers become more demanding and sophisticated which in turn helps firms toward innovative activities.
>
> The presence of rival innovating firms then produces a benefit that loops back into better support. Social networks get created across the competing firms, their customers and their suppliers and this creates a rich environment of knowledge spillovers. Both of these features enhance the supportiveness of the environment for all firms – which serves to attract more firms still, which produces more pressure and more knowledge spillovers, and so on. Overall, the research points strongly in a direction of specialized support and intense competitive pressure and their interaction as being the drivers of competitive performance."[17]

In this Working Paper we:

- Review the current government innovation programs and conclude that these focus mainly on a limited subset of support factors
- Present the data that link over emphasis on a limited set of support factors to under performance
- Indicate how our proposed, more comprehensive model can be used to help frame public policy for strengthening innovation and commercialization
- Set out our research agenda for innovation and commercialization

In summary, public policy attention is increasingly being directed at strengthening innovation and commercialization. The national innovative capacity index identifies some of the reasons for our under performance in innovation measures, such as patenting activities. Importantly, the results indicate that Canada and Ontario cannot rely solely on public innovation policy to gain advantage in the global innovation environment. In order to heighten innovation and commercialization, our firms must shift their focus to derive competitive advantage from original products and processes. This, we argue, will come about from policies that promote both general and specialized support, as well as competitive pressure for innovation. As we see in the next section, many of our policies and programs are based on an inadequate model that focuses almost exclusively on a narrow set of support measures.

[17] *Strengthening structures: Upgrading specialized support and competitive pressure*, p. 19

Support-driven innovation initiatives

Current government policies and investments treat innovation as a narrow support problem

Policy makers in Canada and Ontario seem to be acting on a traditional supply/demand model, seeing the necessity for enhanced supply structures and initiatives as the key innovation challenge for Canada. In terms of our support/pressure model, government policy appears to focus mainly on support factors and within support narrowly in the area of technology and hard sciences. We first review the model that seems to be guiding government policy and then look at the evidence that confirms that government programs and tax policies treat innovation as a supply problem.

Governments apparently see innovation as a supply problem

The economists' model of supply and demand seems to drive innovation policy in Canada. As we review government policies and programs, we conclude that the apparent model driving public policy toward innovation in Canada is that we do not have enough innovation because we have an inadequate supply of certain key factors that lead to innovation. More specifically, we lack innovation in Canada because we have an inadequate supply of scientists and engineers, we lack adequate risk investment funds, and our businesses need incentives to increase the amount of research and development they conduct.

The logic behind the current model starts with the way innovation and commercialization are defined. Governments tend to focus on scientific or technical innovation versus business practice innovation. Thus, innovation is thought of as the result of scientific and technical R&D in Canada's universities, hospitals and research centres. Notably, this R&D accounts for less than half of all R&D spending in the country. Although public innovation derives from a small percentage of the total R&D spending, it naturally receives a lot of attention because public officials control both the level and the allocation of that spending across regions and study areas.

By contrast, more than of half of R&D spending that is performed by business is difficult to track and analyse, partly because the innovations are often incremental (adopt/adapt), and partly because they are process innovations. For example, Masonite, one of Canada's global leaders,[18] developed its leading competitive position in the door products market by a manufacturing process breakthrough and by developing category management skills with home improvement centres that allowed it to serve retailers and customers better. Many of these innovations would not be found in R&D or patent data. Similarly, Cott increased its share of the carbonated beverage market by focusing its operations on the production of retailer brand, or "private label," carbonated beverages, allowing retailers to better target beverages to the preferences of its customers. Again, this innovation would not appear in the public R&D or commercialization data.

From the identification of the centrality of scientific and technical innovation, government attention turns to places where this occurs – scientific and technical departments of universities and other laboratories and research centres. The logic is: "If we had enough people doing innovation and enough money to fund them, we should have enough innovation. Since we do not have enough innovation, these factors must be missing or inadequate."

[18] *Strengthening structures*, pp. 35-36

Exhibit 7 Federal and provincial innovation programs are aimed almost exclusively at a narrow range of innovation support factors, not pressure

FEDERAL INNOVATION PROGRAMS	Summary Description
Natural Sciences and Engineering Research Council (NSERC)	• supports basic research and training in hard sciences and engineering
Canadian Institutes of Health Research (CIHR)	• fund research at life sciences institutes
Social Sciences and Humanities Research Council (SSHRC)	• supports research and training in social sciences and humanities
Canada Research Chairs	• support research professorships – 78% in science, engineering and health research; 22% in social sciences and humanities
National Research Council	• conducts research across physical and life sciences, engineering and technology, information technology and industry support
Canada Foundation for Innovation (CFI)	• provides infrastructure support; primarily in hard sciences
FEDERAL COMMERCIALIZATION PROGRAMS	
Technology Partnerships Canada	• funds R&D projects in environmental technologies, life sciences, information technologies, and advanced manufacturing
Networks of Centres of Excellence	• develop partnerships between the public and private sectors
Business Development Bank of Canada	• provides financial and consulting services to Canadian small business start-ups, with a particular focus on technology and exporting
ONTARIO INNOVATION PROGRAMS	
Ontario Distinguished Researcher Awards	• fund 40% of infrastructure costs of scientists with Canada Research Chairs and those receiving CFI funding; as a result, mostly in hard sciences
Premier's Research Excellence Awards	• attract graduate students to support 'distinguished researchers'
Ontario Research and Development Challenge Fund	• supports people costs; focused on science and technology
Ontario Innovation Trust	• majority of trust used for hard sciences infrastructure costs at universities/hospitals/ research institutes
Ontario Research Performance Fund	• covers indirect costs associated with Ontario-funded research
Ontario Cancer Research Network	• identifies, translates and tests new ideas
Access To Opportunities Program	• increases undergraduate enrolment in science and engineering faculties
Leading Growth Firms	• promotes effective management practices of CEOs of leading Ontario growth firms
ONTARIO COMMERCIALIZATION PROGRAMS	
Ontario Centres of Excellence	• four hard science-based centres help researchers transfer ideas to marketplace
Ontario Research Commercialization Program	• to identify ideas with commercial potential
Ontario Commercialization Investment Funds	• to establish seed capital at universities

Following this logic, governments in Canada have generally provided adequate infrastructure to give general support for innovation and upgrading as we shall see. In addition, they have typically invested in three areas of specialized support: the supply of a scientific and technical labour force, the supply of funds for R&D and the supply of funds for commercialization.

Governments invest significantly in strengthening support factors

Our work confirms that both the federal and Ontario governments have well-developed programs to encourage innovation, but narrowly defined. In fact, we see that nearly all their R&D initiatives are aimed at enhancing supply of technical- and hard science-based innovation (Exhibit 7).

Federal innovation and commercialization programs focus on support – and in the hard sciences and technologies

The federal government funds, administers and supports a host of foundations, organizations, partnerships and scholarships designed to fuel innovation and broaden Canada's R&D base. In all, more than two dozen programs directly and indirectly support innovation and commercialization.

Much of the federal government's research is organized across three funding agencies. The *National Sciences and Engineering Research Council* supports both basic research and advanced training, with $850 million budgeted to support over 10,000 professors and over 17,000 students in 2004–05. The *Canadian Institutes of Health Research* (CIHR) is a specialized program that helps fund over 8,500 researchers working at 13 specialized life science institutes across the country at a level of $662 million in 2004–05. The *Social Sciences and Humanities Research Council* (SSHRC) is by far the smallest of the three, with a 2004-05 budget of $230 million. Within SSHRC, only 8.1 percent of research funding was in the business discipline in 2003–04.

An important role of the three agencies is to allocate funds in the *Canada Research Chairs* (CRC) program. Ottawa provided $900 million four years ago to establish 2,000 research professorships across the country – a move designed in part to keep the most capable and qualified Canadian researchers teaching at Canadian schools. As of April 2004, 1,164 (452 in Ontario) chairs had been established. Fully 78 percent of these chairs are in natural sciences, engineering, and health research with the remainder in social sciences and humanities. Given the low rate of business research funding by SSHRC, only 32 of the 1,164 chairs are in management studies and only seven of these are in Ontario.[19] So despite business degrees accounting for 11.5 percent of all degrees granted in Ontario, management studies receive less than one percent of all Canada Research Chairs in the province.

The three councils are also involved in the direction of the *National Research Council* – Canada's oldest federal research institution. With a 2003–03 budget of over $750 million, it supports 20 research institutes across three major disciplines, physical sciences and engineering, life sciences and information technology, and technology and industry support. Much of the funding is aimed at hard sciences and technology.

Ottawa's flagship infrastructure program is the *Canada Foundation for Innovation* (CFI). Founded in 1997 with an endowment of $3.7 billion, the foundation supports 40 percent of the infrastructure costs associated with a research project (with partners from the public, private and voluntary sectors covering the remaining 60 percent). Since its establishment, CFI has funded 1,362 projects in Ontario worth a total of $857 million. CFI is focused on hard sciences; since 1998, only 15 projects have been funded in the business discipline accounting for 0.17 percent of total funding. Of these three were in Ontario.

A second set of federal initiatives is more directly related to commercialization. *Technology Partnerships Canada* (TPC) is a special Industry Canada agency with a mandate to fund "strategic" R&D. Since its inception in 1997, the program has funded 604 projects worth $2.5 billion, with Ontario accounting for 222 projects worth $1.1 billion. TPC's disciplines consist of environmental technologies, life sciences, information technologies, and advanced manufacturing.

Canada's *Networks of Centres of Excellence* (NCE) are partnerships among universities, governments, private sector firms and non-profits. In 2002-03, with an annual budget of over $77 million, the NCE connected 756 companies, 213 federal and provincial departments and agencies, 48 hospitals, 153 universities and more than 280 other organizations from Canada and abroad.[20]

Finally, the *Business Development Bank of Canada* (BDC) offers a host of managerial and financial services to start-up companies. The BDC currently manages over $400 million in venture capital assets in the fields of life sciences, information and telecommunications and advanced technologies. In the most recent federal budget, the BDC received an extra allocation of $250 million to support start-up and early stage companies.

In summary, federal policies and programs are narrowly aimed at supporting innovation, and within that support they have a narrow focus on the hard sciences, such as engineering and the natural sciences.

Ontario government programs also focus on support for the hard sciences

Ontario programs range from helping universities and colleges to attract and retain distinguished scientists to supporting the human resource and infrastructure costs of research; to providing market research and pre-seed funding; and to fuelling the commercialization process.

Ontario has three programs designed to recognize and reward the work of scientists and scholars. The *Ontario Distinguished Researcher Awards* help individual scientists cover up to 40 percent of their personal infrastructure costs. Last year alone, over $40 million was distributed to 231 researchers at 16 universities – scholars who had already been awarded a Canada Research Chair and who were receiving support from the Canadian Foundation for Innovation. As these two national programs are focused on the hard sciences, so too is this provincial program. The *Premier's Research Excellence Awards* are designed to help those same scientists attract talented graduate students and post-doctoral fellows to their research teams. To date, more than 435 researchers in health sciences, ICT, and materials research have received over $65 million since 1998, with typical awards valued at $100,000 and presented with the caveat that they must be matched on a 2:1 basis by funding from a research institute or private sector partner. The most distinguished and lucrative provincial research award is the Premier's Platinum Medal for Research Excellence, a 10-year, $6 million program – with an annual top prize of $1 million – aimed at keeping Ontario's top scientists in the province.

Through the *Ontario Research and Development Challenge Fund* (ORDCF) and the *Ontario Innovation Trust* (OIT), the province helps defray the costs of both human resources and basic infrastructure. The Challenge Fund was established in 1997 to increase Ontario's research capacity with an initial $500 million endowment, and then topped up with an additional $250 million in 2002. The fund supports up to 22.2 percent of costs, with the remainder coming from the applicants and their partners. Since 1997, the fund has allocated over $435

[19] Canada Research Chairs – Chairholder Profiles [online] available at: http://www.chairs.gc.ca/web/chairholders/index_e.asp
[20] Although NCE operates as a series of autonomous centres, funding is technically provided by NSERC.

million to more than 100 research projects worth close to $1.5 billion. The fund focuses on science and technology.

The OIT helped hospitals, universities, colleges and research institutes fund their infrastructure costs, from equipment and software, to scientific collections and information databases, to building acquisition, renovation and construction expenses. Since its establishment in 1999, the OIT has committed over $895 million to more than 1,240 projects at 44 institutions. OIT funding matches funds from the federal Canada Foundation for Innovation discussed above. With the federal government and more than 900 private enterprises an additional $1.6 billion in funding has been generated. In total, $2.4 billion was invested in Ontario's R&D infrastructure over the past five years. As with most other programs the bulk of funding went to projects in the hard sciences – health and life sciences sector (56 percent of all capital invested), and natural sciences (35 percent). Recipient institutions focused their spending on purchasing equipment (54 percent) and funding construction and renovation projects (35 percent).

In a similar vein, the *Ontario Cancer Research Network* (OCRN) focuses on identifying promising new ideas, translating them into research approaches and subjecting the approaches to rigorous testing. Established with a $100 million endowment, the OCRN disburses $14 million a year in two granting competitions.

The *Access to Opportunities Program* (ATOP) was an Ontario program based on the premise that the province lacks adequate engineering and scientific talent to carry out R&D and to drive innovative activity. In 1998, the Ontario government initiated the three-year program with a $50 million annual funding budget start-up and operating expenditures and ongoing operating funding in universities and colleges. In 1999, another $78 million was allocated to the program. The intent was to double the number of computer science and engineering students graduating each year. But, as we shall see in the following section, the evidence supporting the need for more engineering and science undergraduates is non-existent.

Meanwhile, the four *Ontario Centres of Excellence* were established with the goal of helping researchers transfer ideas and prototypes from the laboratory to the marketplace. Annual funding is $32.2 million, which translates to just over five percent of the $2.4 billion invested in Ontario's R&D infrastructure. The Centres of Excellence have four explicit goals: transferring knowledge; educating and training young scholars; fostering and facilitating relationships between industries and universities; and shaping, supporting and funding research. The four centres focus on the hard sciences:

- *Communication and Information Technology Ontario* (CITO)
- *Centre for Research in Earth and Space Technology* (CRESTECH)
- *Materials and Manufacturing Ontario* (MMO)
- *Photonics Research Ontario* (PRO).

To be sure, not all programs are focused on hard sciences. The *Leading Growth Firms* program provides a forum for CEOs of growing Ontario companies with 20 to 500 employees to share experiences and develop business networks. The program includes publication of reports on effective management practices for innovative companies and monthly peer meetings.

The Government of Ontario is currently reviewing its existing portfolio of innovation programs.

Ontario's two newest support programs are specifically intended to fuel commercialization by funding the costs associated with bringing to market new discoveries from publicly-funded research institutions: the *Ontario Research Commercialization Program* is a $27 million, four-year program aimed at helping universities, colleges and hospitals identify discoveries with commercial potential and attract pre-seed capital; while the *Ontario Commercialization Investment Funds* program offers $36 million to help the same institutions establish pools of seed capital.

In summary, our review of the innovation investments made by the federal and provincial governments is that the vast majority of the funding is to support scholars and their work and that the much of this support is aimed in science and technology.

Tax policies aimed at supporting R&D do not appear to be effective

Canada has one of the most generous tax incentive programs for R&D among OECD countries. But it also has extremely high effective tax rates on business capital investment. The net effect appears to be that tax policy is not helping encourage firms to increase their investments in innovation.

To stimulate R&D investments from Canadian companies, the Canadian federal government has created a generous plan of R&D tax credits. The Scientific Research and Experimental Development Program (SR&ED) gives corporations a 20 percent tax credit for relevant investments in research and development, and gives small private companies (CCPCs) a credit of up to 35 percent of R&D expenditure.[21] These tax incentives have been popular over the years, costing the government of Canada an estimated $1.3 billion in 2003 alone.[22] Additionally, the Ontario government has put in place two programs that augment those credits for small and large corporations.

[21] Smaller CCPCs refer to Canadian-controlled private corporations with prior-year taxable income under $400,000 and prior-year taxable capital employed in Canada under $15 million.
[22] Canada, Department of Finance, *Tax Expenditures and Evaluations 2003*

Despite those incentives, Canada still fares poorly in R&D investments as a proportion of GDP, compared with other nations (Exhibit 8). This is especially true for Business Expenditures in Research and Development, or BERD, the sector of R&D that influences GDP most strongly. Additionally, the BERD investments in Canada have been highly concentrated, with a single telecommunications firm, Nortel, accounting for around 40 percent of all business R&D in 2001.[23]

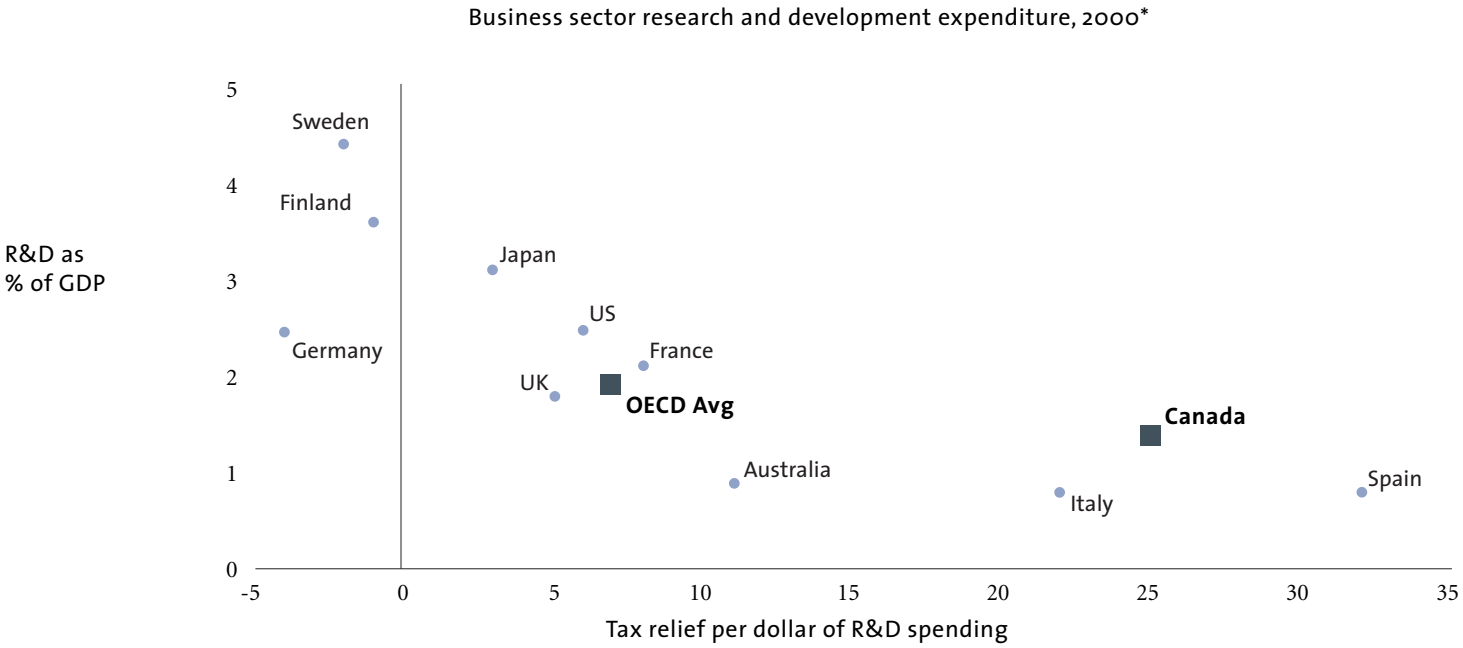
One possible explanation is that the tax credits encourage firms that are already doing R&D to spend more, or simply gives them a tax break for doing the research they were planning to do anyway. Evidence from international research shows that tax incentives do not influence a company's R&D spending strategy.[24] This would support the hypothesis that these credits do little to stimulate firms that do not already do R&D to start the process.

The other potential explanation for Canada's low investment in business R&D is Canada's overall tax structure. Since R&D credits only play a small role in the overall tax profile of a corporation, they may not be the main driver of R&D activity. In fact, as our research into Ontario's marginal effective tax burdens[25] (versus peer states) has shown, our businesses face a significant disincentive to invest in capital and in R&D. The high effective tax rate burdens on business investments have a negative impact on all corporations, reducing their incentive to invest in innovation.[26]

The evidence is unmistakable that governments have in mind a model of innovation that puts priority on a narrow range of support factors. These key support factors are those that drive technology- and hard science-based innovation. The logic seems to be that we do not innovate enough in Canada because we lack an adequate supply of funding for traditional R&D, qualified scientific and technical personnel, and special tax incentives for R&D. However, as we review the evidence in the following section, we conclude that the data point to the importance of other non-technical kinds of support as well as pressure factors to stimulate innovation and commercialization.

[23] OECD, *OECD Economic Surveys Canada, Volume 2003/14 – September*
[24] *Ibid.*
[25] Task Force on Competitiveness, Productivity, and Economic Progress, *Closing the prosperity gap*, November 2002, pp. 36-38 and *Investing for prosperity*, November 2003, pp. 35-38
[26] Jack M. Mintz, *Most Favored Nation: Building a Framework for Smart Economic Policy*, Policy Study 36, CD Howe Institute, Toronto, 2001, p. 103

Exhibit 8 Canada has a generous tax incentive program but a low level of business R&D



** or latest available year*
Source: Institute for Competitiveness & Prosperity, based on *OECD Economic Surveys: Canada,* Volume 2003/14 - September
Note: Negative tax relief numbers indicate tax disadvantage for R&D within country's overall tax regime

Under performance of support initiatives

Evidence indicates that the innovation gap is not a support problem but rather an issue of under performance

In general, as we review the data on innovation factors, we find little evidence to support the characterization of innovation as a support problem, especially those factors on which governments have focused. If support factors were the key challenge facing Ontario's innovation, we would expect to see a much lower level of R&D funds being invested, a lower stock and flow of science and engineering trained people, and less venture capital available for investment.

But, in fact, in R&D expenditure we find that, while Ontario lags its peers in R&D overall, the gap is largely in business investment, not support-driven public investment. In the area of science and engineering personnel, we find that Ontario does not have an overall supply problem. The stock of university educated scientists and engineers actually exceeds US results. In the area of venture capital financing, we find that Canada does not suffer from an inadequate supply of funding.

R&D investment gap has largely been in the business sector

As a percentage of GDP, Ontario R&D investment for the period 1997-2000 is slightly behind the rate achieved by the peer states, but it trails leading states by a significant margin (Exhibit 9). Worse, on a per capita basis, Ontario trails significantly behind the median (17 percent) and fully 71 percent behind the leading state, Massachusetts. So, while we invest a slightly smaller percentage of our prosperity in R&D, because our per capita prosperity is lower, we are investing much less per person than the peer states.

A close examination of Ontario's R&D spending indicates that our gap is in the area of private sector business research and development, not in publicly funded higher education and government research and development. We discuss these two findings after reviewing the evidence of the importance of R&D to innovation and prosperity.

R&D matters

The OECD broadly defines R&D as "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications."[27] R&D comprises basic research, applied research and experimental development and is distinguished from other pursuits, such as design, market research or quality control, in that it is ultimately concerned with the production of original knowledge, processes or products.

Economists have gathered significant evidence of the positive relationship between R&D and productivity and have produced substantial proof that R&D investment is a key driver of long-term prosperity. The research also shows that, while a significant relationship exists between private R&D investment and growth in subsequent productivity, the relationship between government R&D and productivity growth is not as direct. Public R&D may, however, stimulate business R&D, which in turn affects productivity.[28]

[27] OECD, *Frascati Manual*, 1993, p. 29
[28] Zvi Griliches, "Introduction" in NBER, *R&D, Patents, and Productivity*, 1984, p. 18

Statistical tests also show a positive relationship between the change in average intensity of business R&D and the change in multi-factor productivity growth.[29] In addition, R&D investment has been shown to have a positive relationship with patenting,[30] a measure often used as a proxy for innovative activity.

Overall R&D expenditure lags peers, because of shortfalls in business R&D

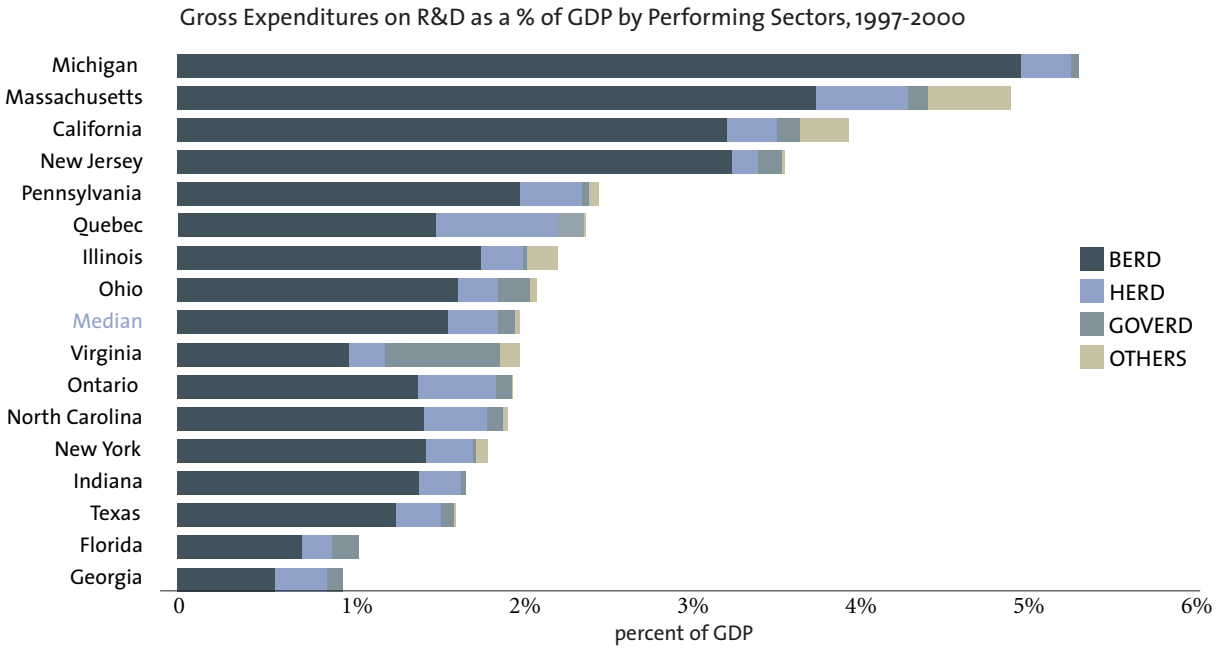
We evaluate R&D by performing sector expenditure because that is the recommended standard across the world.[31] Gross expenditure in R&D (GERD) is typically divided into three main components: business, higher education and government. In the area of business R&D, Ontario lagged its peers through the late 1990s most significantly. This gap has been closing however. In publicly funded R&D – by higher education and governments – we compare more favourably.

Business enterprise expenditure on research and development (BERD) is the main component of GERD. Over the past decade, BERD in Ontario more than doubled, increasing from $3.0 billion to $7.3 billion between 1991 and 2001. As a percentage of GDP, BERD increased from 1.04 to 1.61 percent (Exhibit 10). The sources of funding for business R&D have changed little over this period; most BERD is funded by businesses themselves. The foreign sector has been a major contributor to business R&D, funding an average of over 20 percent of BERD during this period. The importance of the foreign sector to BERD is evident in its high correlation with business funding of R&D over this period; the relationship is even stronger when lagged by one year. This may suggest that R&D expenditure by Canadian businesses is spurred on by past R&D expenditures from abroad. The contribution of government to business R&D has declined in importance; government has funded 5 percent of R&D performed by business, on average, from 1992 to 2003.

Comparing Ontario's performance with our 14 peer states and Quebec, we find that Ontario significantly under performs several jurisdictions, notably Massachusetts, Michigan, New Jersey, and California in terms of BERD per GDP dollar and per capita. Ontario compares more favourably with the median of the peer states, although it still lags over the 1997-2000 period. It should be noted that until 2000, Ontario was well behind the peer group, ranking between 10th and 12th out of 16 in business R&D expenditure as a percentage of GDP. In 2000, the last year for which we have state-specific data, growth in Ontario outpaced

[29] OECD, *The New Economy: Beyond the Hype*, 2001, p. 43
[30] Griliches, Pakes and Hall, *The Value of Patents as Indicators of Inventive Activity*, 1986, p. 3
[31] OECD, *Main Definitions and Conventions for the Measurement of Research and Experimental Development*, 1993, p. 21

Exhibit 9 Ontario performs close to peer jurisdiction median on overall R&D, lagging in business expenditure



Source: Statistics Canada - Science, Innovation and Electronic Information Division; National Science Foundation

median growth in business R&D. More recent Canada versus US data indicate that the gap between Ontario and its peer states may have continued to narrow.

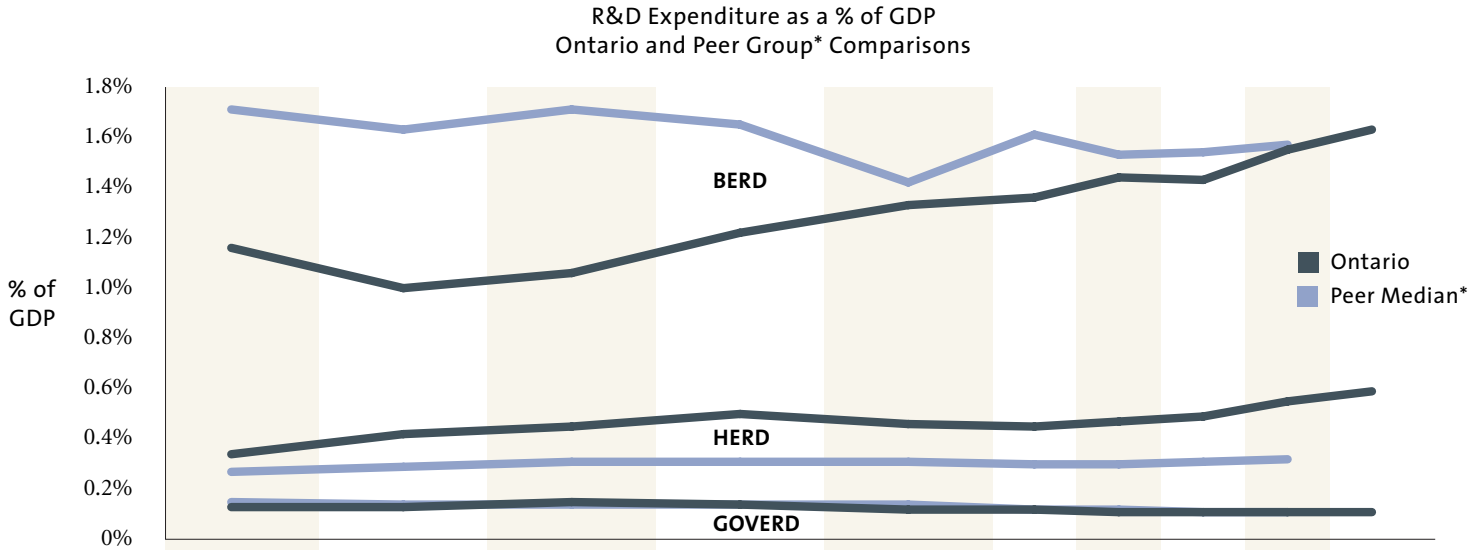
Higher education expenditure on R&D (HERD) in Canada is funded by several sectors. From 1992 to 2003, half of the funding for HERD came from higher education itself, roughly a third came from federal and provincial government sources and the rest came from businesses and private non-profit institutions. HERD has increased steadily in Ontario over the past 20 years. During the late 1990s, HERD increased in response to increases in funding by the provincial and federal governments. In comparison to its peers, Ontario performed well in higher education R&D both as a percentage of GDP and per capita. By 2000, Ontario stood second in HERD per GDP dollar (trailing Quebec). In per capita terms, Ontario trailed only Massachusetts and Quebec in 2000.

Government expenditure on R&D (GOVERD) makes up a small proportion of total R&D performed in Ontario, at 6 percent on average from 1991 to 2001. However, over the same period, the federal and provincial governments funded an average of 25 percent of the total R&D.[32] In the US, government R&D declined over the 1990s and is concentrated in Virginia, where GOVERD was 33 percent of total R&D expenditure over the period from 1997 to 2000. When compared to its peers, Ontario ranks 10th in terms of GOVERD per capita. However, GOVERD is only weakly correlated with total R&D: Michigan, which ranks first in GERD as a percentage of GDP, ranks 12th in terms of GOVERD per capita.

In summary, by the mid-1990s, Ontario approached median performance in R&D as a percentage of GDP. However, the key gap was in business R&D but it too has closed the gap reaching the median of the peer states by 2000. In some sense Ontario's R&D performance is

[32] Of the R&D funding by governments 26 percent of the research is carried out by government departments or agencies, 62 percent by higher education or not-for-profit research institutions, and 12 percent by business

Exhibit 10 Ontario out performs its peers in HERD and has closed the gap in BERD



Ontario's Rank in Peer Group	1987	1989	1991	1993	1995	1997	1998	1999	2000	2001**
BERD	12	11	11	10	10	11	10	12	9	
HERD	3	3	3	3	3	3	3	3	2	
GOVERD	11	11	8	9	11	9	11	8	10	
GERD	13	13	13	11	10	12	10	11	8	

* Including Quebec ** US peer data not available
Source: Statistics Canada, Science, Innovation and Electronic Information Division; National Science Foundation

above expectations given that in our overall competitiveness, as measured by GDP per capita, we ranked 13th in 2001. The challenge for R&D investment in Ontario is more a question of how do we improve the quality of our mix, than how do we increase the overall quantity.

Engineers' and scientists' supply programs may under deliver

Many public programs are based on the premise that Canada and Ontario lack adequate engineering and scientific talent to carry out R&D and to drive innovative activity. As stated above, ATOP is an excellent example of a program developed in response to this felt need. Its goal was to double the number of computer science and engineering students graduating each year.

ATOP is a unique collaboration of government, industry, and education. The implementation of ATOP is a remarkable accomplishment of how fast public policy solutions can be implemented when circumstances are aligned. Reactions from industry and academia to the program have mainly been positive.

Ontario's real need is for more scientists and engineers with graduate degrees

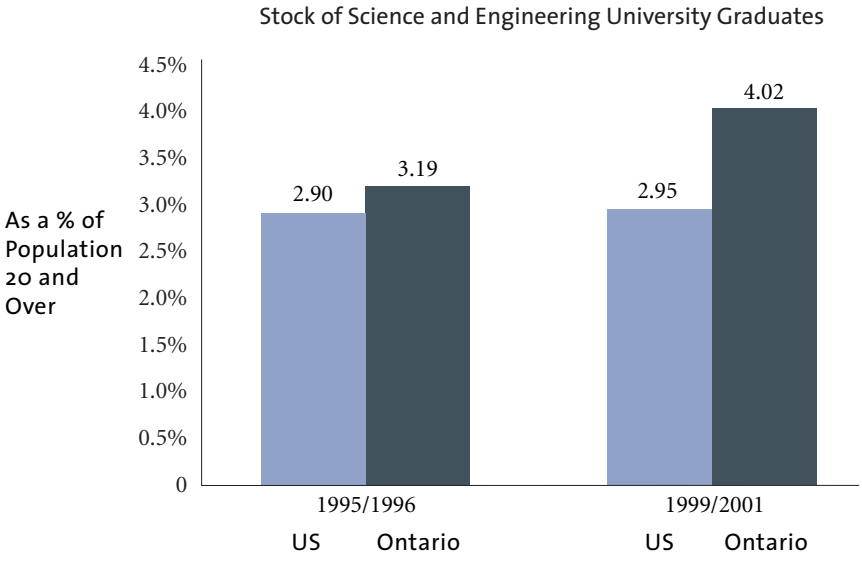
It is unclear whether Ontario really has a significant disadvantage in the number of science and engineering graduates versus the peer states. Our research indicates that Ontario has a slightly higher *stock*[33] of science and engineering graduates in its population than in the US. And it was higher before ATOP was initiated. However, this numerical advantage is restricted to graduates at the bachelor's level. At graduate degree levels, Ontario trails the peer states. In recent graduation performance – the *flow* of graduates – Ontario has been slightly out performing US peers, but again only at the bachelor's level. The overall result is that Ontario continues to lead in overall quantity, but lags in the *quality* of this human capital investment. ATOP focused on increasing the quantity of undergraduates – which was not then or now a disadvantage for Ontario. We surpass the US at the bachelor's level, but trail in the stock and flow of graduate degrees.

More specifically, the percentage of the adult population with science and engineering degrees was actually higher in Ontario than in the US in 1995/6 and this gap has widened since then (Exhibit 11). In 1995/6, Ontario had 3.19 science and engineering graduates per hundred adults versus 2.90 in the United States.[34] By 1999, US results had changed little, growing from 2.90 to 2.95 per thousand people. In Ontario, by 2001, the number grew to 4.02 per hundred adults. The advantage in Ontario is and has been across all science and engineering disciplines – engineering; biology; chemistry, physics, and geology; agriculture and forestry; and mathematics and computer sciences.

Much of this increase can be explained by immigration. For example, well over a third of university educated immigrants to Canada in 1996 possessed degrees in science and engineering.[35] However, graduation data for 1999-2000 indicate that Ontario has been granting significantly more science and engineering degrees than the US. Between 1996 and 2001, the stock of university graduates in Ontario increased by 15 percent. The fastest growing field was science and engineering, increasing by 25 percent.

Nevertheless, comparing the stock of science and engineering graduate degree holders in 1996, we see that the US had a significantly higher percentage of master's and PhD degree holders than Canada (Exhibit 12). This is

Exhibit 11 Ontario has more science and engineering graduates per capita than the US



Source: Statistics Canada; Canism II; National Science Foundation

[33] As noted above Canada trails the US in the WEF's "proportion of scientific and engineering personnel" index. This measures scientific and engineering employment as a share of total employment and is a national number. The data in this section refer to Ontario graduates irrespective of where they are employed

[34] State-level data are unavailable

[35] Schwanen, Daniel, "Putting the Brain Drain in Context: Canada and the Global Competition for Scientists and Engineers," *CD Howe Institute Commentary 140* (April 2000), p. 6

consistent with the recurring theme in our work – Ontario matches peer states in investing for prosperity up to a point, but then trails off as advanced investments are required.

While more recent US data are not available, graduation results indicate that this quality differential has not changed. In 1999-2000, in Ontario 1.24 science and engineering degrees were conferred per thousand population versus 1.13 in the US. However, Ontario's advantage is entirely at the bachelor's level. For graduate degrees conferred, the US outperformed Ontario by 40 percent, 0.29 per thousand population in the US versus 0.21 in Ontario (Exhibit 13). While Canada increased the rate of bachelor's degrees conferred per thousand population during the 1990s, over the same period the rates for MScs and PhDs remained virtually unchanged.

In summary, a key challenge to advancing innovation and commercialization is not in raising the overall numbers of science and engineering degree holders in Ontario, nor was it at the time of the expenditure of $228 million for ATOP. Rather, the task is to increase the number of graduate degree holders working in our companies and public and private institutions.

Venture capital programs focus on quantity not quality

Evidence indicates that the availability of venture capital funds in Ontario is within the range of experience in the peer states. Additionally, labour-sponsored funds have contributed to raising a large amount of venture capital funds in Canada, but their structure and regulations have resulted in lower quality investments that are more likely to have hurt than helped the Canadian venture capital market.

As we have seen, both the federal and Ontario provincial governments have recently committed more funds to increase the availability of venture capital. In fact, the data reveal that

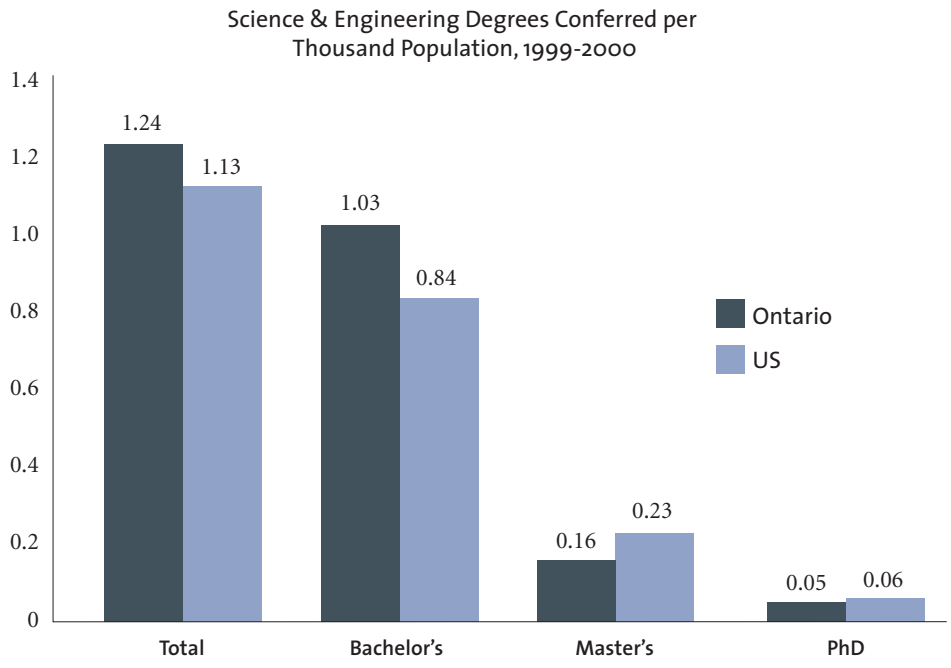
Exhibit 12 Canada trailed US in advanced science and engineering degrees

Stock of Advanced Degrees, Science and Engineering Graduates

1996	Canada		United States	
Field of Degrees	Master's & PhD	PhD only	Master's & PhD	PhD only
	(Number per 100,000 population aged 21 and over)			
Agriculture, Forestry	38	9	31	12
Biology	114	47	150	78
Engineering	286	51	318	58
Chemistry, Physics, Geology	134	66	125	67
Other Science, Mathematics, Computers	124	29	200	31
Total Stock	**696**	**202**	**824**	**246**

Source: Schwanen, Daniel, "Putting the Brain Drain in Context: Canada and the Global Competition for Scientists and Engineers," CD Howe Institute Commentary 140 (April 2000)

Exhibit 13 Ontario exceeds the US in undergraduate science and engineering degrees conferred, but lags in graduate degrees



Source: Statistics Canada Educational Databases; Cansim II; US Department of Education, National Center for Education Statistics

there is no obvious shortage of venture capital in Ontario to fund commercialization, as the level of supply of venture capital in Ontario is comparable with that in other jurisdictions and appears to match demand for venture capital funding.

Venture capital is important to innovation and commercialization

Venture capital is an important component of the innovation environment, providing the resources needed to create successful, innovative firms. Venture capital firms raise funds from traditional pension funds, university and other investment portfolios, large corporations, and individuals. They invest these funds in innovative start-ups typically based on new technology. They provide not only financial resources, but also human resources, lending their expertise and skills to guide fledgling firms and help drive innovation and commercialization of new ideas.

In the US, the birthplace of venture capital, fully 20 percent of public firms in 2000 had been financed in part by venture capital. These venture-backed firms accounted for 11 percent of total sales and about one-third of the value of all public firms at that point.[36] According to Gompers and Lerner, "90 percent of new entrepreneurial businesses that don't attract venture capital fail within three years"; the failure rate for firms who have venture capital backing is around a third.[37] Their research also indicates that a dollar of venture capital stimulates three times as many patents as the same dollar of corporate research and development.[38]

Ontario's venture capital market compares well with US peers, but lags leaders

In comparison with the median of the peer states, Ontario performs well in both venture capital investment as a percentage of GDP and venture capital investment per capita. From 1998 to 2003, venture capital investment was 0.34 percent[39] of Ontario's GDP on average. Over this same period, the peer group median investment as a percentage of GDP was 0.32 percent.[40] Venture capital investment per capita was $126 on average in Ontario and $127 on average for the median of the peers over this period. Hence, it is hard to argue that the quantity of venture capital investment in the Ontario economy has anything to do with Ontario's prosperity gap relative to the median.

During the late 1990s and early 2000s, venture capital investment in North America experienced a "bubble" as investment soared in response to exuberance created in the information technology sector. In 2001 and 2002, venture capital levels fell as the dot-com and telecommunications bubble burst. Clearly, levels of venture capital fluctuate greatly in response to market opportunities.

When venture capital investment is examined at the state level in the US, it is plain that the venture capital market is concentrated in two states, California and Massachusetts. From the late 1960s to the late 1990s, on average over 40 percent[41] of all venture capital investment in the US took place in California and Massachusetts – states that account for 16 percent of the US GDP.

The importance of California and Massachusetts to the venture capital market can be traced back to its origin in the US following World War II. The first venture capital fund, American Research and Development (ARD), was formed in Boston in 1946 and took advantage of the high-tech investment opportunities developing at MIT. Venture capital in the west took off in 1980 when the Apple initial public offering paved the way for the venture capital boom of the 1990s.[42]

The dominant position of California and Massachusetts is evident if we examine their results separately from the rest of the peer states (Exhibit 14). The gap between them and the peer median is significant. When compared to most of its other peers, Ontario venture capital does well, and venture capital levels did not drop as precipitously in Ontario as they did in the US following the collapse of the technology bubble.

One of the features of venture capital funding is that it typically follows the stages of a company's development. From 1996 to 2003, early stage funding made up 45 percent of total venture capital investment in Ontario; early stage funding was 31 percent of the US total over the same period. In dollar terms, early stage funding has declined since 2000 across North America, mainly the result of the high-tech burst when all venture capital investment declined. Interestingly, however, the share of early stage funding increased in Ontario over this period, from 23 to 48 percent of total investment; in the US, it declined from 42 to 19 percent of total investment.

In summary, Ontario has a strong venture capital market when compared to its peers overall. However, some argue that is not sufficient. Just as California and Massachusetts are the leading US jurisdictions in venture capital investments, Ontario is the Canadian leader and should aim higher than the peer state median. But it is unclear whether Ontario can or should aspire to match the levels of venture capital activity in California and Massachusetts. The venture capital market in these two states is older, more mature, and is the result of well-developed financial markets and significant investment opportunities, particularly in high technology

[36] Paul Gompers and Josh Lerner, *The Money of Invention*, Cambridge, Mass. Harvard Business School Press, 2001 and Michael J. Mandel, *Rational Exuberance*, Harper Business, New York, 2004, p.120.
[37] Gompers and Lerner, p. 21
[38] *Ibid.*, p.76
[39] Canadian venture capital data from Canadian Venture Capital Association and Macdonald & Associates Limited
[40] US venture capital data from Venture Economics
[41] Paul A. Gompers, *The Venture Capital Cycle*, 1999, p. 14
[42] Annalee Newitz, "The Short History of Venture Capitalism: How an idea became an empire", Feb. 16, 2000, www.sfgate.com

industries. As we identified in Working Paper 1,[43] the percentage of cluster employment in high-tech sectors in California and Massachusetts is over twice that of Ontario. Clearly, the high level of venture capital investments reflects a well-developed high-tech industry. In addition, since Ontario trails peer states more significantly in other areas – tax burdens and post-secondary education for example – the level of venture capital is not a significant priority for attention.

As we begin our work in the innovation and commercialization policy area, we thought it important to develop an understanding of leaders of innovative firms who have successfully navigated their way through the start-up phases of their business and have built a sustainable business. To that end, we engaged The Strategic Counsel, a Toronto-based market research firm to conduct a survey among venture-backed firms who have achieved sustainability through an initial public offering or have been acquired. The pool of such firms is relatively small – drawing on publicly available information Macdonald & Associates identified 60 such firms. The Strategic Counsel was able to conduct 26 15- to 30-minute interviews with leaders of these firms with good perspective on their company's history.[44]

Many respondents to our survey of successful innovative start-ups pointed to Boston and Silicon Valley as the best developed venture capital markets. They cited broader and deeper sources of venture capital, more specialized expertise in technologies of strength, more seasoned management, and more sophisticated customers. The virtuous circle that exists in these two regions is nearly impossible to replicate in the short term. If Ontario aspires to match the venture capital breadth and depth of Massachusetts and California, it needs to be working on several fronts, not just the availability of venture capital.

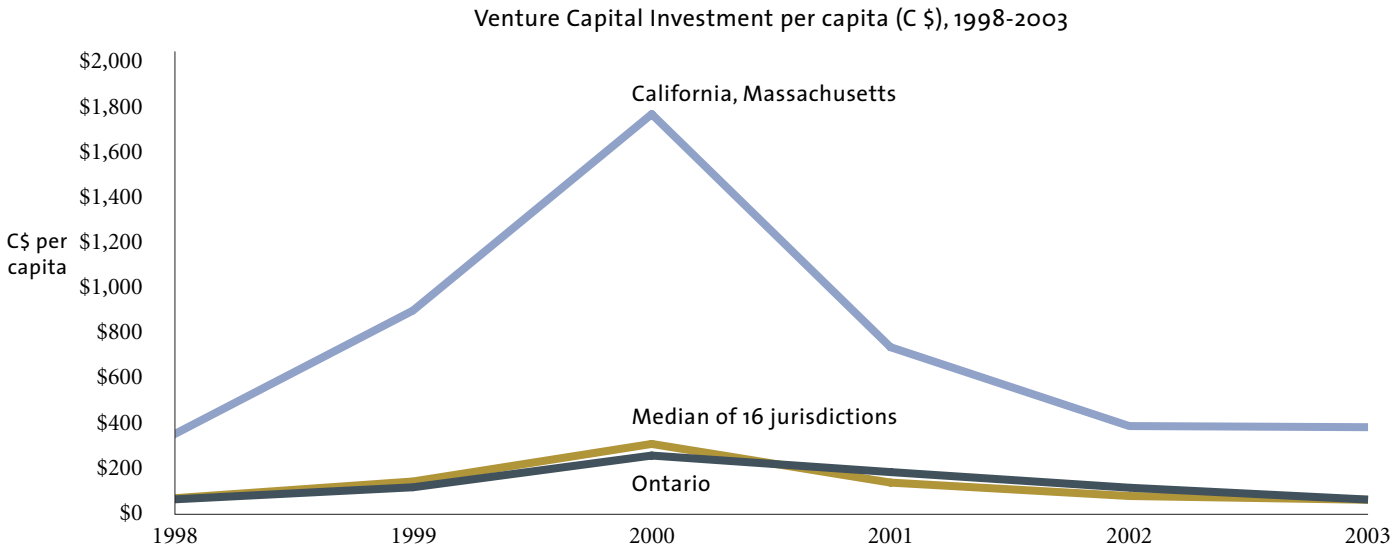
The challenge is to drive for more high quality investment opportunities

As stated earlier, public policy indicates a belief that venture capital represents a supply problem – we have inadequate venture funds. However, we interpret the evidence to point to issues of quality, not quantity for two reasons.

First, over the last three years, the cumulative amount of capital raised surpassed the amount of capital invested by $1.7 billion in Canada (Exhibit 15). To be sure, this follows the 2000 peak when the industry raised $2.1 billion less than it invested. The results indicate a ramp-up of investment funds raised in the 1999–2001 period followed by a return to more normal levels. US experienced a similar pattern; but with less of an imbalance between funds raised and funds invested. It is hard to argue that Canada is suffering from an inadequate quantity of venture capital funds.

[43] Institute for Competitiveness & Prosperity, *A view of Ontario: Ontario's clusters of innovation*, p. 28
[44] Survey results are available on the Institute's Web site, www.competeprosper.ca

Exhibit 14 Ontario compares well in venture capital investment levels, except for California and Massachusetts



Source: Macdonald & Associates (Canadian data); Pricewaterhouse Coopers, Thomson, Venture Economics, NVCA (US data)

The second indicator of a problem with quality, not quantity, is the low returns from this investment class. Canadian venture capital funds have returned a mere 1.8 percent to their investors over the last 5 years, compared to returns of 22.8 percent for their U.S. peers[45] (Exhibit 16).

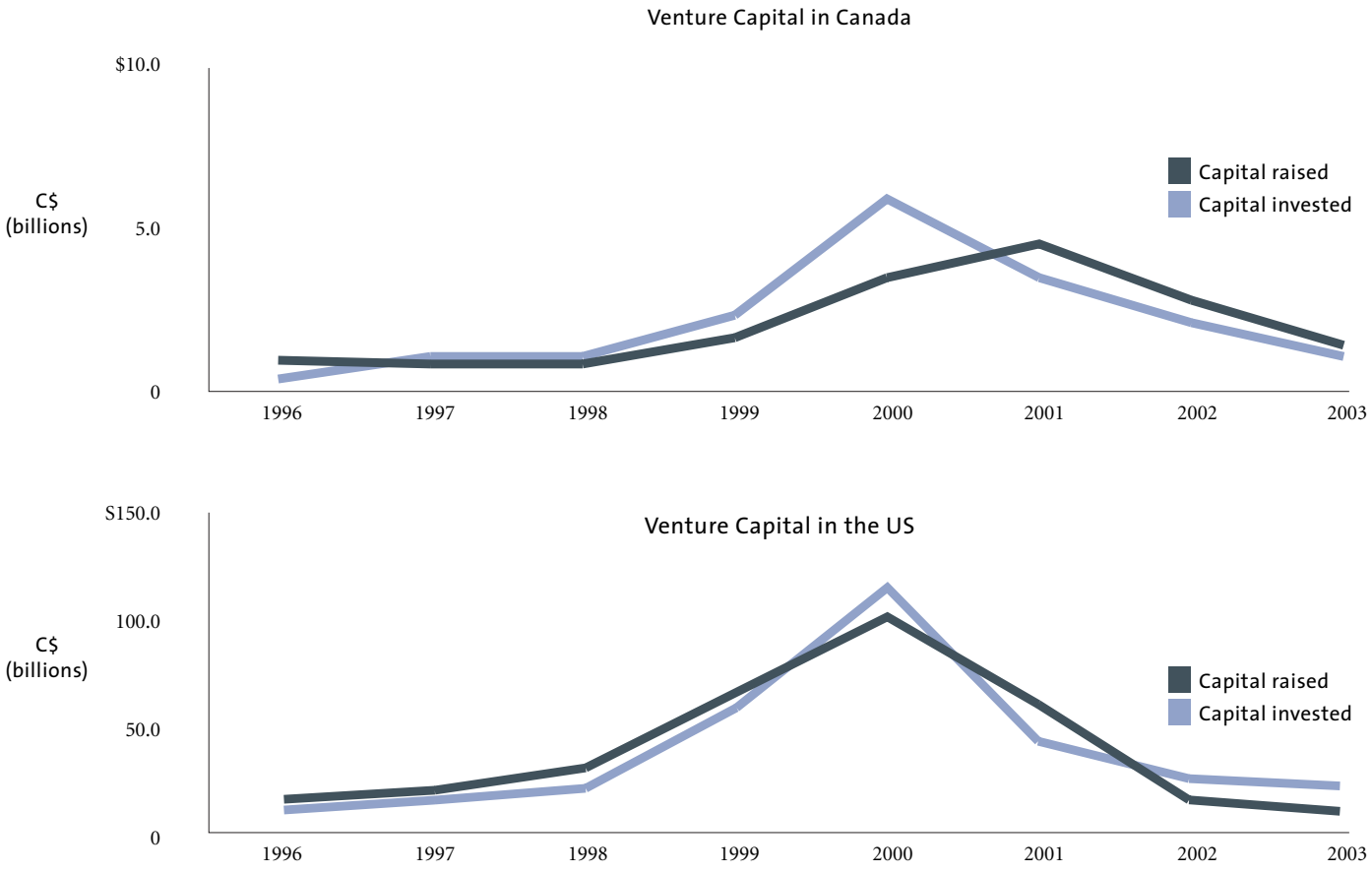
This shortcoming is even more accentuated for early stage venture capital investments, where Canadian funds have seen returns of 3.1 percent over five years, compared to returns of 54.9 percent in the U.S.

There are many factors behind the large supply of funds and poor performance of the Canadian venture capital industry. However, we cannot overlook the presence of Labour-Sponsor Investment Funds (LSIFs) in the Canadian venture capital landscape and their impact on the sector. In 2003, LSIFs alone contributed 67 percent of all venture capital raised in Canada. In the same year, LSIFs were the most important investors in venture capital in Canada, with 31 percent of all funds invested.

LSIFs are a Canadian phenomenon that was born in the mid-1980s as a way to address the recession and a high rate of unemployment. To encourage investments by individuals in LSIFs, the program offers generous tax credits of 15 percent at the federal level and 15 to 20 at the provincial level, provided the investment does not exceed $5,000. Combined with RRSP credits, this can amount to a significant incentive for investors. For example, the total tax credit for an individual with a marginal

[45] Macdonald & Associates Limited, *An Overview of Venture Capital in Canada*, Canadian Venture Capital Annual Conference, May 27, 2004

Exhibit 15 Canada currently has an "overhang" in venture capital funds



Source: Macdonald & Associates (Canadian data); Pricewaterhouse Cooper, VentureEconomics, NVCA (US data)

income tax rate of 46.4 percent amounts to the equivalent of a 10.8 percent return over eight years, the required lifetime of a fund.[46]

These incentives are significant for the individual small investor, and they explain why the funds have successfully raised funds despite low returns. Unfortunately, poor incentives and operational limitations have impeded the returns of the funds. First, because individual investors already receive a high return on their investment through the initial tax relief, they are not overly concerned by the actual return of the fund. Second, the LSIFs are restricted in the type and geography of their investments, and are required to invest some funds in the year they are raised. In 2003, "over 40% of fund resources were deployed in the final three months of the year, when the investment pacing rules of government statutes are believed to play a significant role."[47] It is no surprise, then, to see that their returns have been below average. Recent data show that the median five-year return on a labour-sponsored fund is minus 2.0 percent, while the median five-year return on Canadian small-cap equity funds is 10.8 percent.[48]

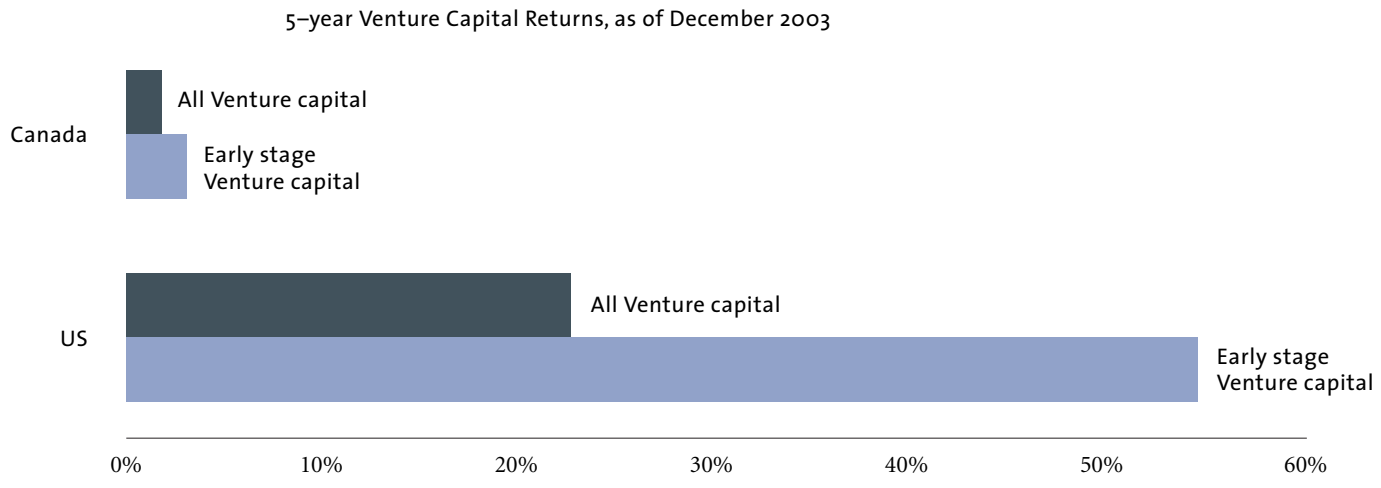
The labour-sponsored program has been successful in raising large amounts of money from retail investors in Canada. However, it may hurt the overall Canadian venture capital industry more than it helps by increasing the supply of venture capital funds and lowering the industry returns. Finally, the program also represents a significant burden on the provincial and federal government, with an estimated total tax expenditure of $3.3 billion between 1992 and 2002.[49] Some have argued that LSIFs are necessary because of the limited participation of institutional investors in Canadian venture capital. They point to reports that Canadian pension funds and foundations invest a lower percentage of their overall assets to private equity in general and to venture capital in particular, than their US counterparts. But recent research suggests that labour-sponsored venture capital corporations "have so energetically crowded out other funds as to lead to an overall *reduction* in the pool of venture capital."[50]

Survey results point to the importance of management and scientific talent as well as financing

In our survey of innovative venture-backed start-ups, we asked respondents to rank three challenges – securing financing, attracting and retaining general management talent (including product management, sales and marketing), and attracting and retaining scientific and technical personnel – in how difficult they were for their company's progress from start-up to success. Availability of financing was mentioned by most respondents as the *sine qua non* for their success. Without adequate capital, nothing else was possible. Respondents indicated that securing managerial talent was a key difficulty; while mentioned as frequently, attracting scientific and technical talent appeared to be less challenging.

[46] Finn Poschmann. 2004. "Better Options for the Venture Capital Market." The Howe Report (private circulation). July.
[47] Macdonald & Associates, 2003 Venture Capital Industry Overview
[48] Finn Poschmann, "Better Options for the Venture Capital Market."
[49] Douglas J. Cumming, Jeffrey G. MacIntosh, "Crowding Out Private Equity: Canadian Evidence", University of Alberta Working Paper. 2003
[50] *Ibid.*

Exhibit 16 Venture capital returns on investment are much lower in Canada than in the US



Source: Macdonald & Associates

Respondents indicated that having managerial talent was critical to attracting financing; they indicated that having scientific and technical talent was less important in attracting financing.

When respondents were asked to rank the same challenges for the company going forward, finance, management, and scientific and technical talent were equally important.

Respondents were also asked to rate their firms against their primary competitor – who tended to be US-based. They pointed to three significant advantages that these US-based competitors had. These were access to financing, access to managerial talent, and access to local customers whose demands stimulate better performance. The net effect of these is that in the US, particularly Massachusetts and California, start up firms can expect greater expertise from venture capital firms in their technology as well as networking opportunities to secure managerial talent and the web of relationships so necessary for success.

Clearly the supply of financing is critical to success for our innovative companies. However, it is not the only key – successful innovation is the result of a host of interconnected factors around pressure and support. Before raising any more venture capital, we need to ensure we are generating new ideas, products and companies that have a strong potential demand in the market, and provide our start-ups with the required support and structures to maximize their chance of success, and consequently, the financial returns of the industry. Other measures, such as lower corporate income tax and lower capital gains tax may be better ways to encourage the venture capital industry without affecting the market conditions as much. For example, the OECD recognized that high tax rates on capital may negatively affect the level of venture capital investment.[51] It evens cites Canada, Japan and some EU countries as jurisdictions with particularly high tax rates on capital.

Again the issue is quality of market structures behind support mechanisms rather than quantity of support factors.

In summary, our research indicates that overall there is an imbalance in public policy initiatives to increase innovation and commercialization in that too much of the overall effort is aimed at a narrow range of support factors. Second, we find that public programs are aimed at areas where improvement opportunities may not be significant or even useful. Third, the approach seems to focus on gross quantity targets, rather than quality. In our view, public policy needs to be informed by a more robust model that includes the full range of support measures as well as competitive pressure.

[51] OECD, *The New Economy: Beyond the Hype*, 2001, p. 78

Specialized support and competitive pressure

Public policy needs to be informed by a fuller definition of support and by competitive pressure

As we have shown, current public policies appear to be guided by a model that points to the need for support of technical resources and people. But the evidence indicates that this narrow type of support is inadequate. A broader set of specialized support factors is required. In addition, attention needs to be paid to strengthening the pressure for businesses to be more innovative.

Broader and deeper specialized support is critical

In the context of general and specialized support, we find that most of our public policies and strategies create adequate levels of general support, but that they address only a narrow set of the specialized support factors required for commercial success. Governments have proposed various solutions to increase the number of scientific and technical personnel, as well as to increase the funding available to researchers. And they have argued that increasing these support factors would translate into higher rates of innovation and productivity in our economy.

But our work shows that Canada still trails the US in specialized support, specifically on factors such as "local availability of specialized research and training" and "university/industry research collaboration." In addition, we find that our venture capital markets are not as sophisticated as required. And finally we lack adequate management talent. These situations lead to important questions.

First, how do we get the right number of engineers and scientists with the right skills? Our model recognizes the importance of science and engineering personnel. Yet the data indicate the challenge facing Ontario is not in producing more bachelor's degree holders. Instead, the challenge appears to be more related to increased specialization and to the demand for these skills. We have already seen that our universities are producing an adequate flow of scientific and technical bachelor's degree holders – using US results as a benchmark. However, fewer of our bachelor's degree holders proceed to achieve higher degrees. And relative to the US, fewer science and engineering graduates are being employed in their field.

Second, how can we strengthen industry-university collaboration? The data on research and development indicate that Ontario is performing well in the level of R&D carried out by higher education. Yet commercialization results achieved by Ontario's universities lag results in the peer states.

Third, how can we get better venture capital returns? Venture capital is important, but we need to ensure that we are not creating an overhang of capital that results in too many projects being funded, thereby resulting in depressed return which may "scare off" skilled venture capitalists from the Ontario market.

Smart management is key

We see that key specialized support factors are traditionally overlooked, such as the quality of management personnel and management schools. Our managers have lower educational attainment overall and in business specifically than those in the US. CEOs of our largest corporations tend less to have formal business education at the graduate level. Once again, we need to address important questions.

First, how can Ontario managers catch up with US managers' education levels? Ontario managers are less educated than their US counterparts. Using 1996 results, the lower educational attainment of Ontario managers versus US managers stands out. Fully 46 percent of US managers possessed a university degree versus 31 percent of Ontario managers. While these data have not been updated in the US, in Ontario results for 2001 are available. They indicate that although the educational attainment of Ontario managers has increased, the results still do not match US results for 1996 (Exhibit 17). A higher percentage of Ontario managers have less than a high school diploma. Fewer Ontario managers have a high school diploma, a bachelor's degree, or a graduate degree.

While generalizations may be risky, few would likely disagree with the hypothesis that a more highly educated manager will think more strategically and operate more effectively. The support and pressure for innovation is likely to be higher in an environment of more highly educated managers.

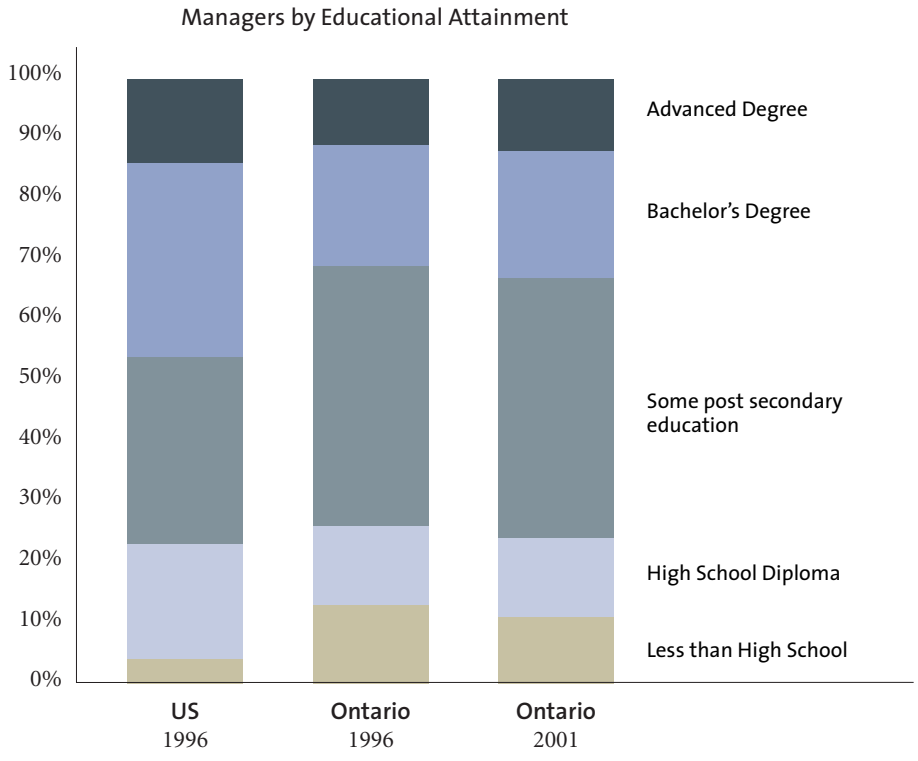
Second, how can we increase number of managers with business degrees?
Ontario managers are less likely to have a bachelor's degree or a master's degree in business than US managers. Comparing 1996 US data with 2001 Ontario data, we find that 6 percent of Ontario managers possess a business degree at the bachelor's level versus 14 percent in the US. At the graduate level, the US advantage is 6 percent versus 3 percent. In the school year 1999-2000, the US conferred almost exactly twice the number of business degrees per capita as Ontario (1.331 degrees per thousand population versus 0.662). This advantage held at all three levels of degrees – bachelor's (2.14 times as many in the US as in Ontario); master's (a 1.73 times advantage for the US); and PhD (a 5.5 times advantage for the US).

As we have seen, Ontario graduates as many scientists and engineers at the bachelor's level as the US, but fewer at the graduate levels. However, Ontario graduates significantly fewer students from university business programs. This disadvantage is not because our students lack the desire for business education. Undergraduate business and MBA programs face among the longest waiting lists and the lowest percentage of acceptance rates in all of Canadian higher education. If more spots were available, many more students would fill them.[52]

Third, how can Canadian Chief Executive Officers match US counterparts' business education levels? At the pinnacle of Canadian corporations, we find a lower incidence of MBAs than in the US. We compared the educational attainment of the CEOs of the 100 largest US corporations as defined by *Fortune* and the 100 largest Canadian companies as defined by the *Financial Post 100*.[53] We found that 37 percent of US firms were headed by an MBA versus 24 percent in Canada. Since the 100 largest US firms are much larger than the 100 largest Canadian firms, we checked on the impact of size on this measure. When we analyzed the firms ranked between 400 and 500 on the *Fortune* list, we found that the percentage of these smaller US firms lead by MBAs was 36 percent.

Fourth, how do we strengthen management skill development in established companies? In our survey of successful venture-backed

Exhibit 17 Ontario managers are less well educated than their US counterparts



Source: Statistics Canada; US Census Bureau

[52] Roger L. Martin, "The Demand for Innovation in Canada", p.11
[53] Excluding foreign-owned and government-owned companies. In some cases the CEO post was vacant. We excluded those companies and replaced them with companies immediately below the 100 rank.

start-ups, respondents indicated a key challenge in Ontario is in securing seasoned management talent. In their experience, they had to look to the US for the manager who had solid business experience in companies with track records in management development, as well as experience in the relevant technology. Most cited scale factors as the key strength of the US in this area. It is a much larger market with greater opportunities and pressures to hone managerial skills. We need to determine how to overcome this scale disadvantage to create more such opportunities in Ontario.

Obviously, many business managers and leaders succeed without a formal university education, let alone business education. In fact, on both sides of the border, this is the case in the majority of situations. But it is hard to overlook the significant difference in the educational attainment of our business people and the lower number of formal business degree holders in Ontario and Canada. And it is hard to avoid the logical connection between this human capital difference and higher US competitiveness and prosperity as defined by GDP per capita and more successful innovation as defined by patents per capita. And it should be recalled that Canada's major disadvantage versus the US in the World Economic Forum's National Innovative Capacity and the Business Competitive Indices is related to company operations and strategies. Our human capital is likely not driving innovation and upgrading – given the lower levels of formal education our business managers have. It is unclear which is cause and which is effect. Our environment may not put the pressure on businesses to strengthen their human capital. Additionally, our lower level of human capital may not create the intensity of competitiveness necessary for innovation and commercialization. Most likely these two factors reinforce each other in a vicious circle.

Pressure for higher competitive intensity will spur business innovation

We see a lack of intense competitive pressure to stimulate demand for innovation and commercialization, including the rivalry of firms in the industry, and the sophistication of customers in Canada. A key element of enhancing pressure for innovation is the presence of sophisticated business strategies and operations. Businesses that depend on innovation for survival and success will demand greater innovation in their own firms and from others such as universities and research institutes. The evidence indicates that Ontario is not benefiting from this pressure.

If we want to solve the commercialization challenge, we must create a higher demand for innovation. To do this, we must look at the competitive pressures that face our leading companies and what can be done to encourage businesses to be more competitive in their marketplace.

In Working Paper 5, *Strengthening structures: Upgrading specialized support and competitive pressure*, we identified the relatively low level of competitive intensity (versus US peers) as a key factor in our reduced capacity for innovation and upgrading. We found that Ontario has many of the structures in place for driving innovation and higher productivity. But these structures lacked an adequate level of specialized support to ensure the complete success in our industries. More specifically[54] we found that:

- The World Economic Forum's Business Competitive Index identified important disadvantages where Canada's industries lacked competitive pressure – buyer sophistication and intensity of local competition

- Our analysis of some specific clusters in Ontario identified the lack of specialized support and competitive intensity as a key differentiator between effective clusters (such as automotive and steel) versus less effective clusters (e.g., biopharmaceuticals, education and knowledge creation, and tomato processing)

- A review of the firms in Canada and Ontario who are global leaders in their industries indicates that the degree of competitive intensity in Canada (from sophisticated customers and capable rivals) has not been a significant factor in producing the leaders we do have

- These factors result in reduced effectiveness of our firms' strategies and operations. Without the intense pressure to innovate and upgrade and the benefit of specialized support, our firms tend to be rated lower in the Business Competitive Index in company spending on research and development; competing on the basis of low cost or natural resources rather than unique products and processes, and performing the full range of value chain activities in their operations.

As we review the findings from our previous work and assess our latest research, we conclude that Ontario's key challenge is to create the environment in which companies can and must innovate and commercialize. Our business leaders do not face the same competitive intensity as their US peers and are not getting the specialized support they require. Both shortfalls require attention. But the toughest public policy challenge is how to intensify competitive pressure – how to encourage the rivalry that will lead firms to take innovation actions to outpace their competitors and how to raise consumer expectations for leading products and services. Clear answers and policies can help close the innovation – and in turn the prosperity – gap with high-performing peer states.

[54] See *Strengthening structures: Upgrading specialized support and competitive pressure*, pp. 31–41 for more detail

Integrated innovation agenda

Ideally, governments and businesses will implement a robust model to develop integrated initiatives to create support and competitive pressure for innovation and commercialization

As the Institute begins its exploration of the challenges and opportunities in innovation and commercialization, we have identified the following key issues we intend to pursue in our future research. These issues are organized in the framework of support and pressure we have developed to guide our analysis.

Strengthen specialized support initiatives for quality

We have a challenging agenda.

Understand how to strengthen collaboration between business and universities, hospitals, and other public research institutes

As we have found, the World Economic Forum survey points to research collaboration between universities and industry and to the lack of specialized research and training facilities as weaknesses in Canada's Business Competitive Index. We intend to identify the key factors at play in the development of close collaboration between business and university – exploring best practices in the peer states and opportunities in Ontario for strengthening specialized support.

Determine how to develop a well functioning venture capital market

Our research presented in this Working Paper indicates that, relative to the peer states, a shortage of venture funds is not a problem for Ontario. Nevertheless, many observers are concerned about sub-scale deal sizes and small venture capital firms, the lack of real specialization so necessary in a smaller market like Ontario, and the poor returns experienced from venture capital investments. We intend to deepen our understanding of the forces at play in our venture capital markets with a focus on strengthening Ontario's capacity for innovation and commercialization.

Understand the human capital challenges to supporting innovation and commercialization

Our research indicates that our stock of science and engineering graduates is higher than in the peer states. Yet the research indicates that we confer a lower number of graduate degrees per capita than the peer states. In addition, the evidence indicates that fewer of our science and engineering degree holders are actually working in the field. These two factors may be related – people working as researchers require graduate degrees and we have fewer of these. We intend to shed more light on this issue by examining flows of students through the post-secondary system and into industry.

Continue our investigation into the impact of business education on the support for innovation and commercialization

While we have a similar output of science and engineering degrees versus the peer group, albeit with fewer graduate degrees, Ontario trails the peer group in both the quantity and level of business degrees conferred. There is also evidence that our managers and leaders are less likely than their counterparts in the peer states to have formal business education. Despite the apparent demand among young people for formal business education, an inadequate supply of university spaces is reducing the flow of new business graduates, relative to the peer group. This inadequate supply of spaces is the result of decisions by governments and academic leaders and we think it important to understand the factors at play. As we have argued, more sophisticated business managers and leaders will support more innovation and commercialization – and without this, other measures to strengthen support will be inadequate.

Intensify pressure for business competitiveness

Competitive intensity is essential for innovation and upgrading. Firms without strong rivals will tend to conduct business as usual. And without demanding consumers, they are less likely to try to find ways to be out in front. Ontario firms need ongoing pressure to beat their rivals and win sophisticated customers. We will seek ways to help them do that.

Identify policy opportunities for strengthening competition in Ontario's markets

In Working Paper 5, we identified the lack of competitive rivalry as a factor reducing the effectiveness of our clusters. We saw that industries such as biopharmaceuticals, communications, transportation, and financial services have historically been protected from the full forces of global competition or have been regulated in a manner that precludes beneficial rivalry. This lack of rivalry has reduced the pressure for innovation and upgrading. We intend to investigate some of these important industries to identify opportunities for strengthening competition between firms and enhancing sophistication of customer demand with a focus on how this might strengthen innovative capacity.

In summary, to get the right factors in the right place, policy makers need to reinvent how they think about the challenge of innovation and commercialization. From a focus on a narrow set of support factors, they need to broaden and deepen their objectives and implement programs to encourage more specialized support and intensify competitive pressure in both the public and private sectors. Business leaders as well as scientists have major roles to play in contributing to upgrading and innovation in Ontario to close the productivity gap and raise the prosperity of all Ontarians.

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