Chapter 1

Unleashing business innovation

This chapter discusses how to improve Canada's business innovation in order to boost labour productivity and output growth. Many general framework conditions are highly favourable to business risk-taking and innovation, including macro stability, openness, strong human capital, low corporate tax rates, low barriers to firm entry and flexible labour markets. However, they can be improved further by reduced external and interprovincial barriers in network and professional service sectors, more efficient capital markets, fewer capital tax distortions and improved patent protection. A second focus should be on ensuring that incentives arising from government subsidies are targeted on actual market failures. The very high level of support to business R&D via the federal Scientific Research and Experimental Development (SR&ED) tax credit and provincial top-ups may weaken the incentives of small firms to grow and should be redesigned. A plethora of small, fragmented granting programmes, mainly geared to SMEs, should be streamlined for better academic-business collaboration. The large public share in venture capital should be wound down, as it may crowd out more productive private finance. A final focus should be on boosting manager and worker skills that are intrinsic to all forms of innovation, by filling gaps in training, mentoring and education.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Innovation is the key long-run driver of productivity and income growth. It is likewise the main means of confronting looming structural challenges in Canada and other OECD countries. Innovation to boost product quality and variety will enable Canada to stay competitive against formidable new global suppliers; breakthroughs in agriculture and energy seem to be more necessary than ever to reach the elusive goal of green growth; and radical cost-reducing innovations in health-care organisation and delivery are needed for the affordable care of ageing populations.

At the same time, global economic forces may be acting to constrain innovation in Canada (Rao, 2011). Alongside sluggish recovery in the OECD, which accounts for the bulk of Canada's export markets, strong non-OECD growth has induced large terms-of-trade shifts for Canada, causing resources to move from areas of increasing returns to scale (tradeable manufactures) to those of diminishing returns (exhaustible resources). This reduces aggregate R&D capacity and contributes to environmental degradation. Competition for highly skilled people worldwide, including by the large emerging markets, is increasing while their supply within the OECD is shrinking due to accelerating baby boomer retirements. This may hamper businesses' ability to innovate and adopt technology. Hence, policies should be oriented to providing a domestic environment that is conducive to innovation and human capital accumulation.

Innovation is most likely to flourish under sound structural conditions. There may be various reasons for more specific public intervention that provides a framework for innovation by private business and accords an appropriate level of protection to its fruits while encouraging their diffusion (OECD, 2007). Public subsidies can help to overcome the failure of financial markets to invest sufficiently in intangible assets, which are hard to value and plagued by information asymmetry problems, yet in the case of business R&D have strong spill-overs. Public policy can further assist the transition to a knowledge economy through provision of vital public goods like education and basic research (Chapter 2), while compensating the lower skilled and others who are made worse off as a result of technological change. All OECD countries currently implement a mix of policies aimed at supporting innovation, and many are reinforcing them in light of the global crisis.

The Canadian productivity paradox

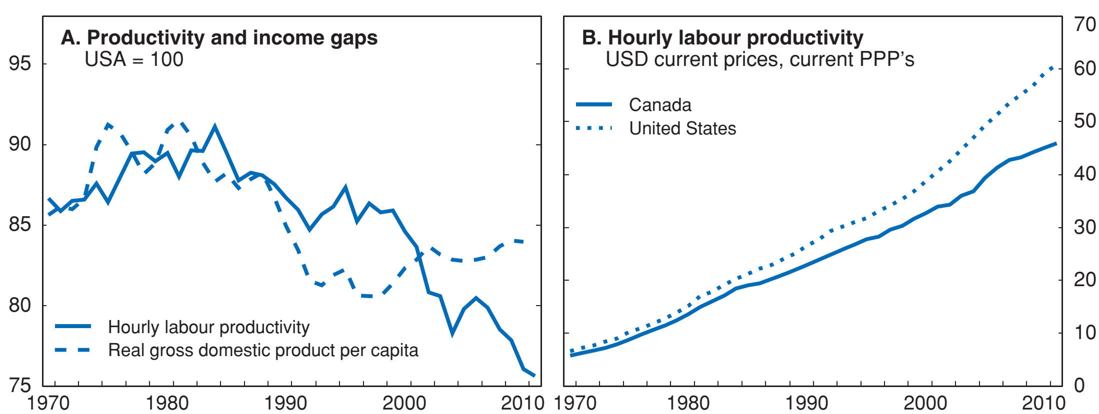
A striking paradox that has baffled Canadian policy makers and researchers alike is this: despite rich natural and human-capital endowments, generally strong institutions, social capital and policy fundamentals, deep economic integration with the technology leader (the United States), and ample public spending in support of innovation, Canada's business innovation activity is by any aggregate measure lacklustre, and productivity growth has persistently lagged behind that of its OECD peers.

Canada is one of the few OECD countries to trail the United States in productivity growth over a long period of time. Comparisons with the United States are compelling for two reasons. First, similar geography, endowments, free-market institutions, cultural and social affinities, high cross-border labour mobility and close trade and investment linkages might on the whole point to expected convergence rather than divergence. Second, efforts have been made by the Canadian statistical authorities to correct for numerous inconsistencies *vis-à-vis* the United States in the measurement of real output, labour and capital inputs, and although measurement issues remain, notably regarding PPP price deflators, quality adjustments for ICT and capital depreciation rates (Baldwin and Gu, 2009; Tang *et al.*, 2010), they mainly affect comparisons of productivity levels rather than growth rates.

Persistently weaker Canadian productivity growth since around the mid-1980s has opened up a significant and widening gap in productivity levels with the United States (Figure 1.1). As the latter is Canada's major competitor, this has contributed to rising relative unit labour costs in Canada. The Canada-US productivity growth gap can be entirely attributed to a longstanding multi-factor productivity (MFP) growth shortfall (Table 1.1). Capital deepening, except in the recession of 2008-10, and improvements in labour quality (as measured by changes in educational attainment rates) have been somewhat stronger in Canada. By 2010, the capital intensity of the Canadian economy was some 110% of the US level, whereas MFP was only about two-thirds as large.

Figure 1.1. **Economic performance of Canada relative to the United States**

Total economy



Source: Centre for the Study of Living Standards (2011), *Aggregate Income and Productivity Trends, Canada vs United States – www.csls.ca/data/ipt1.asp*; *OECD Annual National Accounts Database* and OECD calculations.

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Table 1.1. **Decomposition of Canada-US gap in average annual labour productivity growth**

Differences in percentage growth rates: Canada minus the US, business sector

	1961-2010	1961-1980	1980-2000	2000-07	2008-10
Gap in labour productivity growth	–0.2	0.4	–0.4	–1.7	–2.8
a) Capital deepening	0.3	0.8	0.2	0.1	–1.0
b) Workforce composition	0.2	0.4	0.1	0.1	0.0
c) Multifactor productivity	–1.0	–1.0	–0.6	–1.8	–1.8

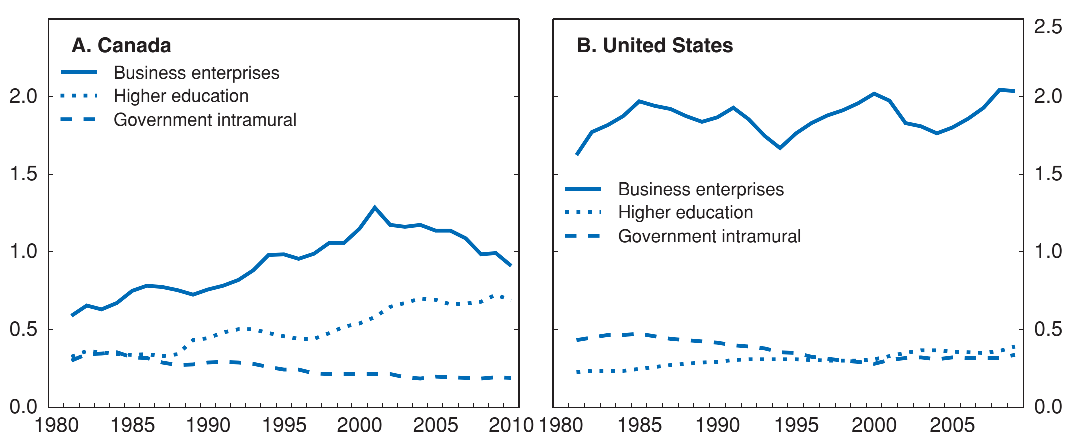
Source: US Bureau of Labor Statistics and Statistics Canada.

MFP can be broken down into three components: average returns to scale, allocative efficiency effects and a technological residual (Basu, 2010). The last can be viewed as the benefit of innovation proper and is in turn a function of factors like public infrastructure, the "free" receipt of knowledge externalities from academe and other firms, management and organisation, human capital of workers and managers, "own" R&D and other investments. Policies to boost productivity should be targeted at all three components: firm growth, resource mobility and innovation. This chapter will focus on innovation, though all three channels are mutually reinforcing and tightly bound. For example, adjustments to economic shocks occur via innovations to adapt to the new conditions but also depend on the ability to reallocate resources to successful innovators, allowing them to grow and prosper, while less adaptive firms exit (Andrews and de Serres, 2012). Thus, many factors influencing innovation will also affect resource allocation and growth capacities.

Empirical studies suggest that the Canada-US MFP gap is related to three underlying and interdependent gaps in: R&D; machinery and equipment (M&E) investment, in particular ICT; and human capital, specifically university education attainment of the working population which is 31% higher in the United States (Rao, 2011). Business expenditure on research and development (BERD) is often considered to be the best single predictor of MFP growth (Jaumotte and Pain, 2005). Canada's BERD intensity is less than half of its US counterpart, and since 2001 it has steadily declined, whereas that of the United States initially dipped but then bounced back (Figure 1.2). Both countries' R&D capacities were strongly shocked by the bursting of the ICT bubble in 2001, but Canada was harder hit by the subsequent commodity price boom and exchange-rate appreciation, which induced resources to move from manufacturing (which is R&D intensive) to mining and oil and gas extraction (which are not). Higher education expenditure on R&D (HERD) in Canada has grown steadily since the early 1980s, while government expenditure on R&D (GERD) has drifted downwards; the opposite pattern can be seen in the United States. These various gaps may reflect differences in economic structure, but only partly (see below).

Figure 1.2. **Research and development expenditure**

As a percentage of GDP



Source: OECD.stat, *Main Science and Technology Indicators Database.*

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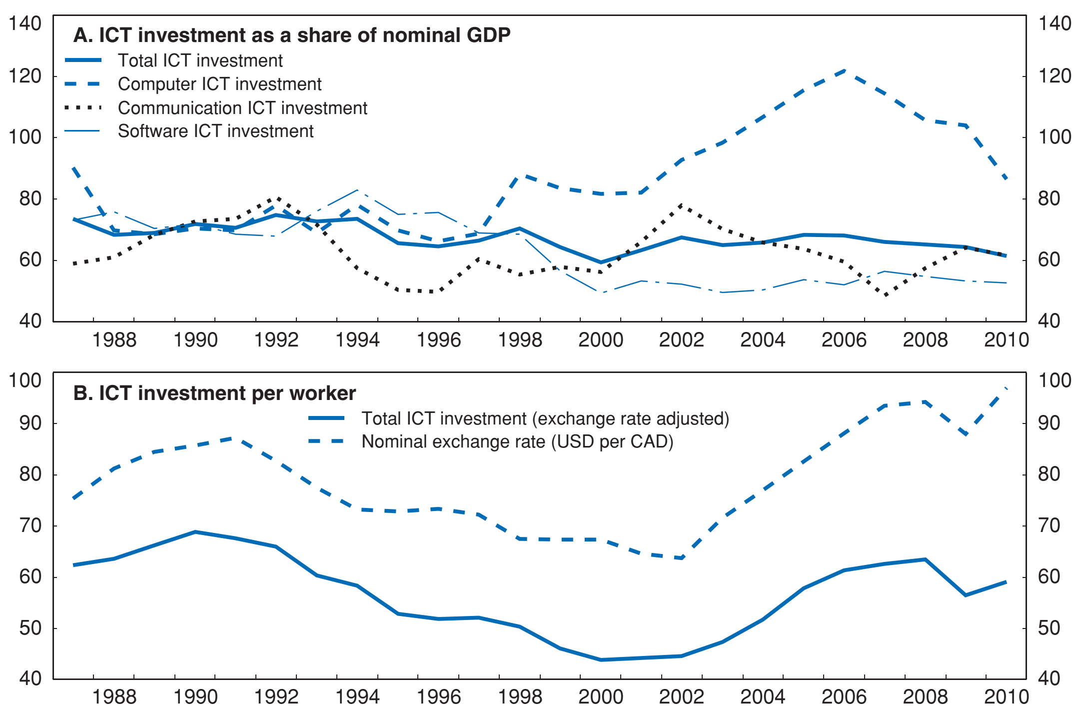
Research has found a significant positive correlation across Canadian industries between the MFP and ICT capital-intensity gaps (Rao *et al.*, 2008). The wide gap in ICT investment per worker displays a marked correlation with the exchange rate, likely reflecting that during the long period of currency weakness, the cost of ICT capital (most of which is imported) was inflated relative to the cost of labour, and conversely since the dollar has appreciated (Figure 1.3, Panel B). Within non-M&E, the Canadian advantage reflects engineering capital (pipelines, utilities, oil and gas sector, etc.), the intensity of which is four times the US level (Baldwin and Gu, 2009).

Figure 1.3. **ICT investment in Canada relative to USA**

USA = 100



Source: Centre for the Study of Living Standards, database for *information and communication technology*; OECD (2011), *Economic Outlook 91 Database*.

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The Canada-US productivity gap might reflect structural composition, as opposed to a systemic problem. While such structural differences may explain a part of the gap, research indicates that it is not large, while the *levels gap in MFP* is widely spread across the economy. Negative gaps are particularly large (30-50% below the US level) in sheltered sectors like utilities, information and culture, arts and entertainment, and professional, scientific and technical services and high-tech manufacturing, which also tend to be highly knowledge intensive and dynamic, exhibiting increasing returns to scale (Table 1.2). While a number of sub-sectors show productivity near or above US MFP levels, notably oil extraction, manufacture of raw materials, food processing, and services open to competition (*e.g.* construction, wholesale trade, waste management), many of these are at the lower value-added end of production.

Table 1.2. **Labour productivity, multifactor productivity and capital intensity comparisons**

USA = 100

Sector or Industry	Labour productivity		Multifactor productivity		Machinery and equipment	ICT
	2002	2007	2002	2007	2000-07 average	2000-07 average
Goods sector						
Agriculture, forestry, fishing and hunting	85.5	86.4	82.8	86.2	70.5	79.1
Mining	88.9	88.0	79.3	72.5	80.0	31.2
Mining, except oil and gas industry	58.1	47.3	52.2	39.4	57.0	35.1
Oil and gas extraction industry	87.9	81.6	94.9	100.3	100.5	25.6
Utilities	76.5	62.7	53.9	49.0	51.0	73.6
Construction	149.5	192.5	151.8	196.9	79.2	14.7
Manufacturing	84.4	73.2	91.1	77.2	91.1	36.6
Service sector						
Wholesale trade industries	73.7	90.0	97.8	120.3	29.9	45.6
Retail trade industries	81.3	75.6	95.3	85.5	70.4	72.1
Transportation and warehousing industries	123.8	108.1	112.5	96.7	86.8	19.7
Information and cultural industries	64.5	46.6	69.9	52.3	82.8	98.5
FIRE[1] and management of companies industries	70.0	72.1	75.7	74.9	105.4	72.2
Professional, scientific and technical services industries	45.4	38.6	54.0	47.6	45.7	42.3
Administrative and waste management industries	113.5	107.6	144.1	126.2	39.9	49.9
Education, health care and social assistance industries	99.4	95.9	102.0	98.0	34.2	17.8
Arts, entertainment and recreation industries	39.6	39.0	49.4	47.9	39.3	128.7
Accommodation and food services industries	74.1	72.2	85.2	78.8	28.3	47.1
Other services (except public administration) industries	145.3	143.8	181.6	178.3	61.1	102.1
Average for all sectors and industries (business sector)	77.3	72.1	75.4	68.5	74.5	47.9

1. FIRE stands for finance, insurance, real estate and leasing.
Source: Tang *et al.* (2010).

Given the sheer magnitude of the 2002-12 terms of trade uptrend, it could be hypothesised that the decade's fall in MFP is just a composition effect in response to the workings of comparative advantage. However, over time, the within-sector effect appears to dominate the effect of changes in composition for the business sector as a whole (Table 1.3). Much of the weakness is accounted for by the mining sector, where MFP fell by over 6% at an annual rate as high oil prices made profitable the exploitation of marginal reserves of a depleting resource.

Firm turnover and growth are an important source of MFP growth. For the United States and other countries, entry and exit rates facilitate aggregate productivity growth by the process of creative destruction. This process may not be as effective in Canada as in the United States. Specifically, Leung and Cao, (2009) find that, contrary to the United States, job creation and destruction are negatively correlated in Canada, implying that job destruction following economic shocks is associated with slower redeployment, and possible product- or labour-market rigidities. A major source of firm dynamics is also in the middle of the size distribution. There is little direct evidence as yet on the impact of firm dynamics on the Canada-US productivity gap (Rao, 2011). However, the unincorporated sector (sole proprietorships and partnerships) is responsible for a sizeable portion of the Canada-US productivity gap: self-employment, which is less productive, is relatively high in Canada, and partnerships are much less productive than in the United States. As unincorporated firms are often at the first stage in their life cycles, the gap in productivity

Table 1.3. **MFP growth decomposition**

	Value-added share		MFP (index 2002 = 100)		Within-sector effect	Shift-share effect[1]
	2000	2008	2000	Per cent annual growth 2002-08		
Agriculture, forestry, fishing and hunting	2.9	2.4	109.7	1.68	0.05	–0.51
Mining and oil and gas extraction	7.9	13.4	110.3	–6.25	–0.49	5.68
Utilities	3.4	3.0	91.7	0.34	0.01	–0.40
Construction	6.5	9.3	94.8	–0.72	–0.05	2.68
Manufacturing	24.4	15.0	102.3	–0.71	–0.17	–9.49
Wholesale trade	6.6	6.8	96.6	1.84	0.12	0.14
Retail trade	6.7	7.2	93.5	1.56	0.10	0.52
Transportation and warehousing	5.7	5.4	102.4	–0.51	–0.03	–0.31
Information and cultural industries	4.2	4.3	93.1	2.25	0.09	0.10
Finance, insurance, real estate and renting and leasing	14.1	14.2	99.5	0.04	0.01	0.13
Professional, scientific and technical services	5.7	6.3	99.0	–0.33	–0.02	0.63
Other services (except public administration)	12.1	12.8	98.6	–0.62	–0.08	0.65
Business sector	100.0	100.0	100.0	–0.60	–0.45	–0.18

1. Includes interaction term.
Source: Statistics Canada.

could reflect not so much a lack of entrepreneurs at the early-development stage as a failure to grow this dynamic group, *e.g.* due to smaller market size. It is also possible that tax incentives encourage the more productive small firms to incorporate more frequently in Canada or paid workers to become self-employed (Baldwin *et al.*, 2011).

The state of innovation

Innovation is a multifaceted activity and difficult to measure because of the intangible nature of its output, which is new knowledge proximately and productivity (MFP) ultimately. Available indicators show a mixed picture of Canadian performance, with strong basic research but weak commercial pay-off.

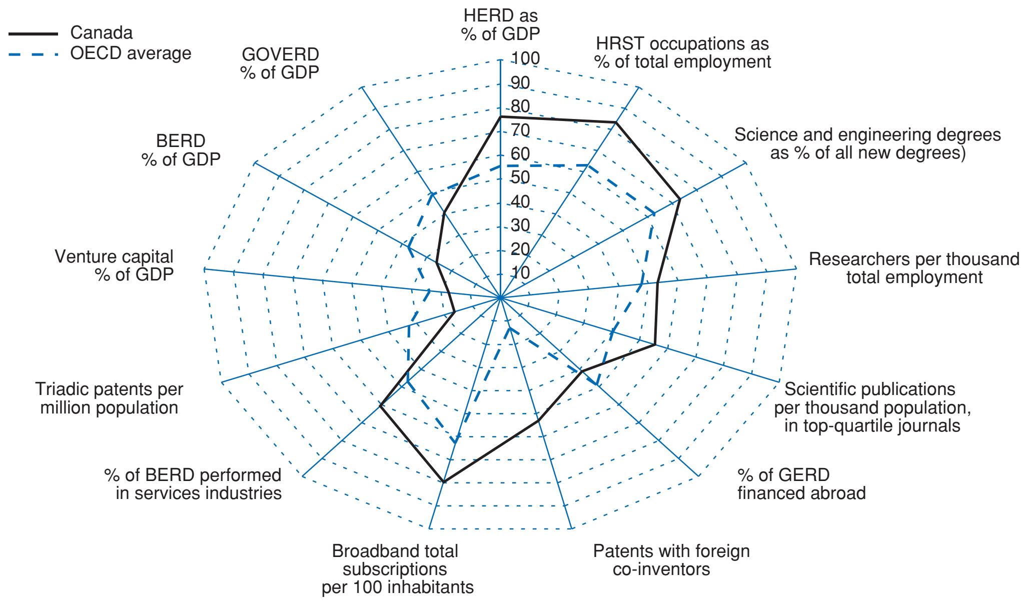
The innovation ecosystem

The public supply of knowledge

Making Canada a global science and technology (S&T) leader has long been a policy objective, one that has to a large extent been achieved in the realm of academic output. The public supply of knowledge is rich in Canada, as measured by two key indicators: scientific articles per capita (quality adjusted for journal ranking) and spending on higher education R&D in proportion to GDP (HERD), which is fourth highest in the OECD (Figure 1.4). The public education system has likewise apparently kept up with the needs of the knowledge economy. The workforce displays a high share of human resources in science and technology (HRST). Science and engineering degrees, as well as the number of researchers, are slightly above their OECD averages. Innovation policy as a whole is still mainly viewed through a traditional S&T lens, centred on the universities, though this is slowly changing in line with growing recognition of a commercialisation gap between academic and applied research. BERD and patenting, which are positively correlated, are two areas where Canada does not perform well compared to other OECD countries. This might seem surprising, given both the quality of its human capital and the level of fiscal

Figure 1.4. **Science and innovation profile of Canada**[1]

2010 or latest available year



1. For each indicator in the radar graph, the OECD country with the maximum value is set at 100 (with a position on the outer ring of the radar). The average is calculated by taking into account all OECD countries with available data.

Source: OECD.dat; *OECD Science, Technology and Industry Outlook 2010*; *OECD Science, Technology and Industry Scoreboard 2011.*

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support given to business innovation, the third highest in the OECD. It should nevertheless be noted that Canada performs well compared to other OECD countries for the incidence of innovation, as measured by innovation surveys (OECD, 2009; see also Figure 1.5 below).

The imbalance between world class academic research and lacklustre business R&D has led policy makers to re-examine the linkages between academe and business. The recent Jenkins report for the federal government (IPFSRD, 2011) recommended that the National Research Council (NRC) – which governs the main public research institutes – be reconfigured to be more focused on demand-driven applied research better able to serve the needs of business. This refocusing has already gotten underway, and in its new budget the federal government has committed to carrying it further. The relatively high level of broadband penetration, thanks to strong public support, has also provided critical infrastructure for enhancing the spill-over benefits of public and private innovation (Figure 1.4).

Business demand for innovation

Innovation encompasses more than science-based activities. However, significant measurement issues are involved in capturing of innovation inputs more broadly. According to experimental Statistics Canada data, R&D represents only about one-quarter, and purchases of intellectual property (IP) another quarter, of all estimated intangibles investment (Box 1.1; Table 1.4). A key missing link, as also suggested by preliminary OECD cross-country data (Table 1.5), may be managerial ability to commercialise knowledge developed within Canada.[1] Furthermore, adapting technology from abroad may be less productive than performing "own" R&D, given that spill-overs from the latter are likely to be much larger (Andrews and de Serres, 2012). The large numbers of S&T personnel not performing R&D may be engaged in less productive adaptive and implementation activities (Figure 1.4).

Box 1.1. **Capturing innovation through intangible investments**

Innovation covers a broader range of science-based investigative activities than just R&D, extending to non-scientific forms of knowledge creation with commercial and social value potential. R&D pertains to basic and applied research and experimental development geared toward the acquisition of new knowledge and the resolution of uncertainty concerning its practical applications. Most business R&D occurs in the pre-commercial experimental development phase, whereas most basic and applied research is undertaken by university and public sectors (IPFSRD, 2011; MacIntosh, 2012). The knowledge produced by R&D is mostly patentable, and its key characteristic is novelty. Later stages of the innovative process concern mainly the implementation of the new concept, *i.e.* its integration into production. Non-R&D scientific activity usually encompasses such later pre-commercialisation stages. Engineering and production departments often contribute to innovation in its earliest stages, suggesting ideas that are later developed by R&D departments (Baldwin *et al.*, 2009). IP is also purchased for later commercialisation via licensing of patents, contracting out of R&D and other professional (*e.g.* business, engineering, architectural) services to other firms or academe. Software and related database development occurs within firms or it may be outsourced. With the increasing importance of services sectors to economic output and innovation activity, organisational and managerial innovations, as well as training and marketing, are gaining in importance relative to product and process innovation that are chiefly associated with manufacturing. Design is increasingly a key component of innovation in all its aspects, and many countries are giving it greater policy prominence (Diamond and Lewis, 2011). This is not to say that the traditional interest in R&D is becoming any less important. If anything this focus will grow, as revolutionary innovations will almost always be science and technology based, even in services.

Statistics Canada (Baldwin *et al.*, 2009) has made estimates of business-sector intangible investment including the full scope of science-based innovation along with advertising (branding) and resource extraction. Over the past three decades, business investment in intangibles has grown markedly faster than in tangibles, and by 2001 outweighed business fixed investment in importance (Table 1.4). Over the entire period, R&D represented only about one-quarter of total innovative investments, purchases of external IP another quarter and non-R&D scientific activity plus a small amount of software the other half. Manufacturing and services (notably professional, scientific and technical services) accounted for the bulk of R&D investments and of non-R&D scientific in-house investigations, in roughly even amounts. Services as a whole were much more heavily engaged in advertising and software investments. Purchases of external IP were mainly carried out by manufacturing where it is notably larger than in-house R&D; this

Table 1.4. **Intangible investments**

Business sector, as per cent of GDP

	Advertising	Mineral exploration	Innovation science				Total science	Total intangible investment
			Purchased science and engineering	Own-account				
				Research and development	Software	Own-account other science		
1981	1.5	0.5	1.9	1.5	0.2	2.7	6.4	8.3
1985	1.6	0.5	1.8	1.6	0.3	2.9	6.7	8.7
1990	1.9	0.3	2.2	1.6	0.5	3.1	7.4	9.6
1995	1.7	0.4	2.1	1.9	0.7	3.0	7.8	9.9
2001	2.1	0.8	2.6	3.6	0.9	3.2	10.3	13.1
Average 1981-2001	**1.8**	**0.5**	**2.1**	**2.0**	**0.5**	**3.0**	**7.7**	**9.9**
of which (%):								
Goods	36.2	100.0	80.3	45.6	20.0	47.1	54.0	53.1
Services	63.8	0.0	19.7	54.4	80.0	52.9	46.0	46.9

Source: Baldwin *et al.* (2009).

Box 1.1. **Capturing innovation through intangible investments** *(cont.)*

may in part reflect the large auto sector, which tends to import its R&D from its US and Japanese parents. It is also very significant in the construction sector, which outsources virtually all of its architectural and engineering IP. Mining and exploration activities, which, though not classified as R&D or even as scientific innovation, are constantly being adapted to new challenges and contain a high degree of sophisticated science and engineering content. Emerging high technologies that are attempting to limit the environmental damage wrought by resource extraction involve a significant amount of measured R&D, moreover (STIC, 2011).

The OECD has published experimental figures on intangibles for a set of OECD countries, including Canada, for around the year 2006 (Table 1.5). Following a slightly different classification than above (narrower for R&D and broader for branding activities and including economic competencies like worker training and organisation capital), it shows less but still sizeable intangible investment in Canada. The OECD figures also suggest that Canada's main lag *vis-à-vis* the United States is to be found in managerial, marketing and organisational rather than scientific human capital. They also point to a strong lead by Canada in total intangibles investments *vis-à-vis* the OECD average. The fact that it is not reflected in relative productivity performance reinforces concerns about the quality of science-based innovation and/or the ability to commercialise it.

Table 1.5. **Intangible investments, selected OECD countries**

Business sector, as a per cent of GDP

	Computer-ised information	Innovative property				Economic competencies				Total
	Software	Scientific R&D	Mineral exploration	Copyright and licence costs	Other product development design and research	Brand equity: Advertising	Brand equity: Market research	Firm specific human capital	Organisation capital	
Australia (2005-06)	0.77	0.82	0.26	0.07	1.10	0.76	0.11	0.45	1.57	5.90
Canada (2005)	1.03	1.83	1.14	0.11	1.92	0.40	0.09	2.15	1.11	9.78
Japan (2005)	2.14	2.88	0.00	1.01	1.94	1.14	n.a.	0.38	1.18	10.67
United States (2007)	1.38	1.82	1.01	n.a.	1.82	1.43	n.a.	4.01	n.a.	11.43
EU27 + Norway (2005)	1.04	1.04	n.a.	0.83	0.48	0.61	0.32	0.53	1.63	6.49

Source: INNODRIVE Intangibles Database, May 2011, *www.innodrive.org/*; Fukao, K., T. Miyagawa, K. Mukai, Y. Shinod and K. Tonogi (2008), "Intangible Investment in Japan: New Estimates and Contribution to Economic Growth", *www.euijtc.org/news/events_2007/20080719/Fukao.pdf*; Barnes, P. and A. McClure (2009), "Investments in Intangible Assets and Australia's Productivity Growth", Australian Government Productivity Commission Staff Working Paper, Canberra, Australia; Corrado, C.A., C.R. Hulten and D.E. Sichel (2006), "Intangible Capital and Economic Growth", National Bureau of Economic Research, Working Paper 11948; Belhocine, N. (2009), "Treating Intangible Inputs as Investment Goods: The Impact on Canadian GDP", *IMF Working Paper*, WP/09/240, November.

Intangible investment should cumulate to a stock of knowledge assets entering the economy's production function. Currently, intangibles expenditures are subtracted from revenues as an expense rather than added to demand as an investment (except for software and mineral exploration). But, insofar as they provide a flow of services lasting more than one accounting period, they should properly be considered as investment rather than intermediate expenditures, albeit with depreciation rates presumably much higher than for physical capital. If all intangibles were to be reclassified as investment, this would significantly boost GDP and productivity measures. If all countries were to do this, Canada's relative productivity performance might improve, given its strong intangibles investment flows, though early estimates of the GDP impact of capitalisation of intangibles suggest otherwise (Andrews and de Serres, 2012). R&D expenditures have indeed been capitalised in the 1993 System of National Accounts (SNA93), though only in the satellite accounts. This area remains a significant challenge for statisticians.

System performance

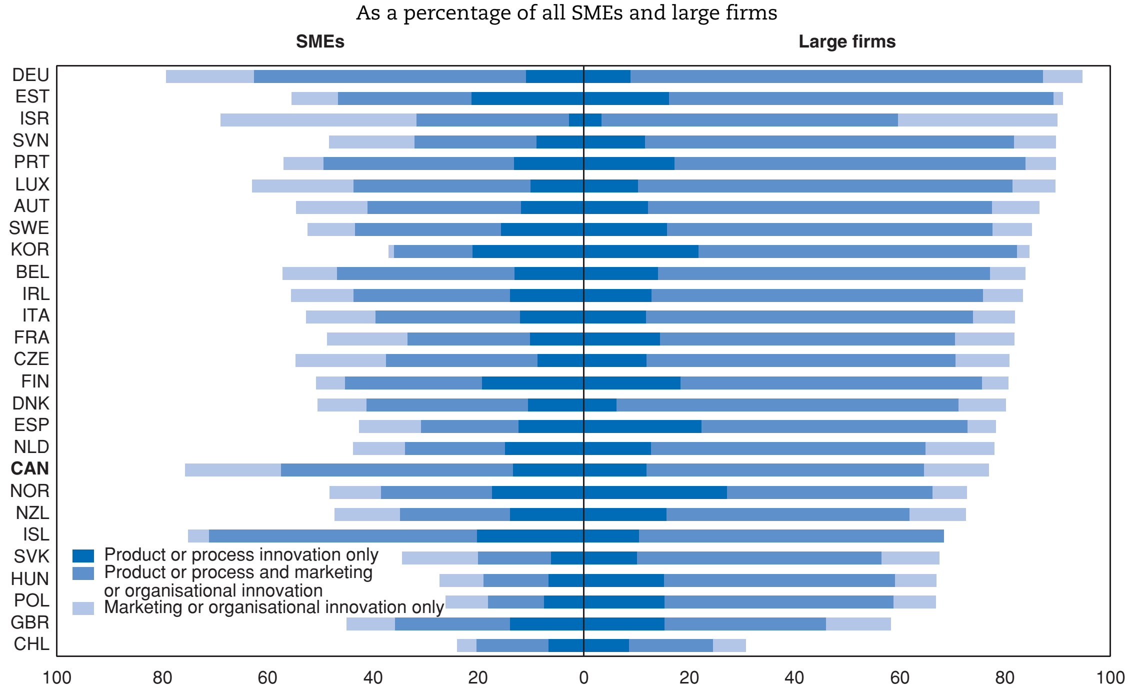
Weak (and indeed, negative) MFP growth may imply a relatively unproductive pattern of innovation. For example, there may be too many S&T human resources devoted to engineering processes in industries of declining MFP (Figure 1.4), and – despite many outstanding exceptions – too few efforts devoted to original R&D or organisational (workplace, global supply chain, etc,) innovations may be holding back MFP growth. Furthermore, the fact that BERD intensity is comparatively low and declining, whereas fiscal support to BERD is substantial and rising, suggests either inefficiency of such policies and/or countervailing barriers to innovation.

Firm-level evidence

The 2009 Canadian *Survey of Innovation and Business Strategy* (SIBS) (Government of Canada, 2011), based on updated notions of the OECD's Oslo manual (OECD and Eurostat, 2005), indicates that a large share of firms in all sectors introduced one of the four types of innovation between 2007 and 2009. Comparing across firm sizes and with other OECD countries, this share was particularly high among SMEs (Figure 1.5), possibly reflecting the large proportion of public support devoted to SMEs (see below). The SIBS also substantiates complementarities in the different types of innovation and between innovation and other business activities – product innovations being frequently coupled with organisational and marketing activities, a result also found in the EU Community Innovation Survey (CIS) – and the greater likelihood that manufacturing rather than non-manufacturing firms will adopt advanced technology. The survey also gives some perspective on what businesses themselves see as the main challenges to their ability to innovate effectively. Respondents have identified uncertainty and risk as the biggest

Figure 1.5. **Innovation strategies by firm size, 2006-08**[1]

As a percentage of all SMEs and large firms



1. Canada, 2007-09; Chile, 2007-08; Korea, manufacturing, 2005-07; New Zealand, 2008-09.

Source: OECD (2011), *OECD Science, Technology and Industry Scoreboard 2011.*

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obstacles to innovation, followed by lack of skills and then lack of internal financing. Regulatory issues and IP protection were not seen as major problems, though the former is relatively more important for medium-sized firms and the latter for larger firms.

Research has tried to assess the relative output benefits from product *versus* process innovation, with possible policy implications. Jaumotte and Pain (2005) find (at the macro level) that product innovations have higher productivity impact. OECD (2009), using firm-level microeconomic data, also finds that product innovations are highly productive in terms of sales per employee, while process innovations reduce productivity, at least in the short run, perhaps reflecting transition costs. Van Leeuwen and Klomp (2006) using CIS data for the Netherlands, obtain a similar result and suggest that it may reflect a missing endogenous employment response (*i.e.* process innovation causes unit labour use to fall but total employment expands due to increased competitiveness in output markets). The latter study also finds: *i*) a strong impact of innovation output (measured as sales of innovative products) on demand and thereby on MFP growth, suggesting that science is relevant mainly for the explanation of inputs into innovation, but that the use of market sources for technological inspiration (customers, suppliers or competitors) contributes more directly to innovation output and MFP; but also *ii*) a sizeable impact of permanently performing R&D on the level of innovation output (absorptive capacity hypothesis). Such studies seem to confirm the importance of all types of innovation and their joint use.

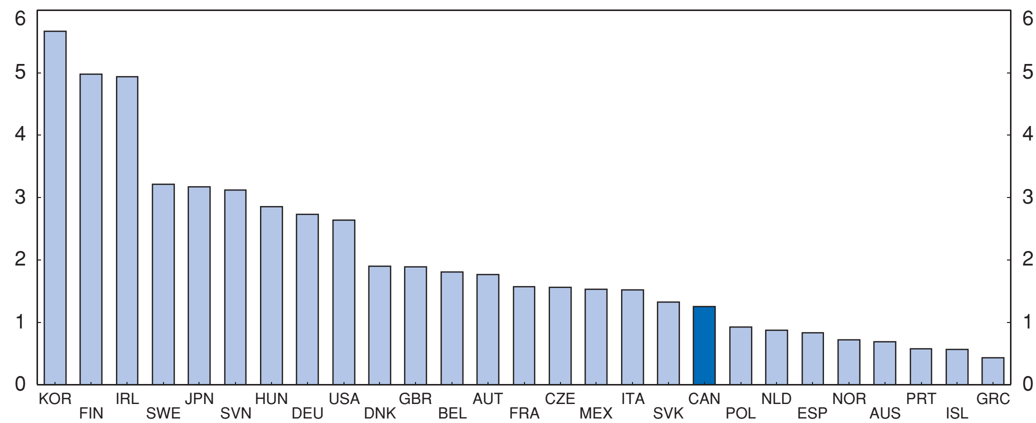
What seems needed is more research on the economic and social benefits of the main types of intangible investment (R&D, organisational, purchased S&T, non R&D scientific activity, software, mineral exploration, branding); the OECD is in the early stages of just such a project (Andrews and de Serres, 2012 and OECD, 2012b). Early research supports the hypothesis that investment in ICT is a important driver of MFP, because it is the vehicle through which innovations are put to use, implying important complementarities (spill-overs) between R&D, human capital accumulation and ICT investments (Rao, 2011). Corrado *et al.* (2012) find strong positive interaction effects between ICT and intangible investments in the determination of MFP growth in a panel of European countries plus the United States. These authors suggest that countries may benefit from tax breaks to software in addition to those often given to R&D and training, whereas the major tax advantages to tangible capital are less warranted given the lack of spill-over from such investments.

International comparative advantage

A large technology deficit on the balance of payments and many patents with foreign co-inventors (Figure 1.4) are likely to reflect structural features of Canada's "branch plant" economy, *i.e.* the strong role of US subsidiaries that frequently draw on technology flowing from the United States. Innovation could thus be viewed as a comparative advantage of the United States, with Canada importing R&D from the technology leader (as an early adopter), while supplying resources and resource-based semi-finished goods for export. However, absorptive capacity requires that a critical mass of innovation be performed within the technology-importing country itself. Empirical work by the OECD has identified two significant effects of R&D on productivity and growth: the first is a direct effect of R&D on innovation creation and the second an indirect influence through the absorption of new technology. The importance of the indirect effect depends positively on the distance from the world frontier of each industry (Nicoletti and Scarpetta, 2003). While Canada is at the forefront of a number of industries, notably those that are natural resource based, it appears to be rather far from the R&D-intensive high-tech manufacturing frontier (Figure 1.6); it follows that Canada should raise industrial R&D in order to better exploit the

Figure 1.6. **Share of high technology manufacturing in GDP**

2009 or latest available year



Source: OECD.stat, *STAN Database* and *OECD Economic Outlook 91 Database.*

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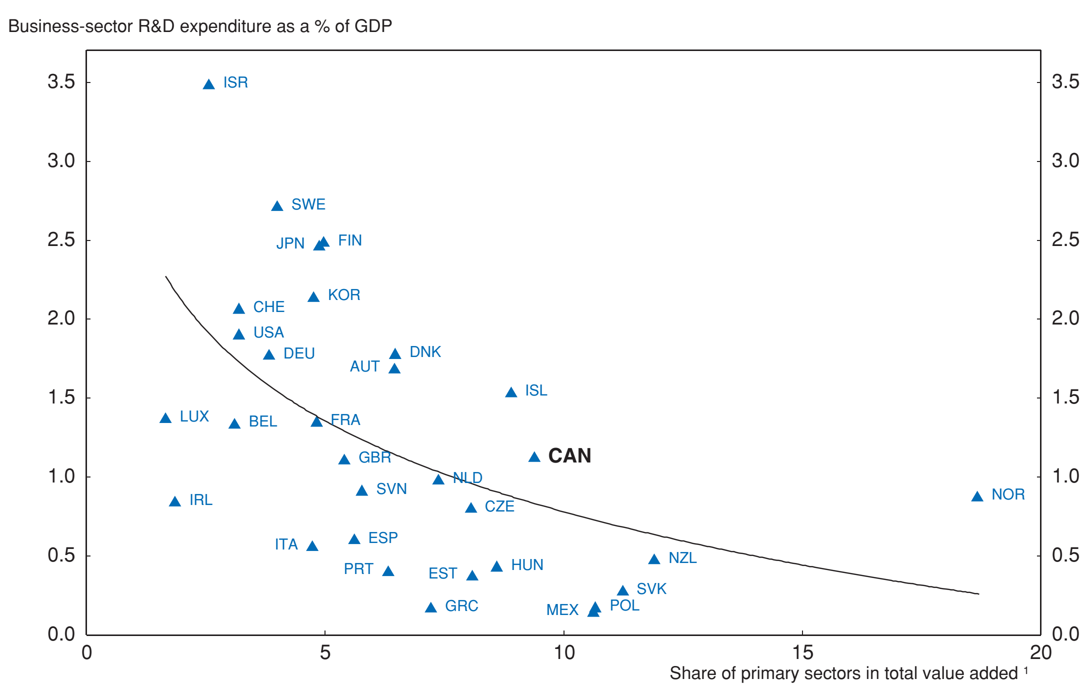
indirect benefits of absorption, whilst moving steadily toward the technology frontier by means of both direct and indirect channels of effect.

Natural resources may matter for innovation propensity. It is indicative that resource-rich countries like Canada, New Zealand and Norway all appear to underperform when it comes to innovation (controlling for GDP), whereas their resource-poor counterparts like Israel, Korea and Japan, are highly innovative (Figure 1.7). This may

Figure 1.7. **Business R&D intensity and natural resource intensity**

Average of 2000 to latest available year



1. Primary sectors include agriculture, forestry, logging and related activities, fishing and related activities and electricity, gas and water supply.

Source: OECD.stat, *Main Science and Technology Indicators Database.*

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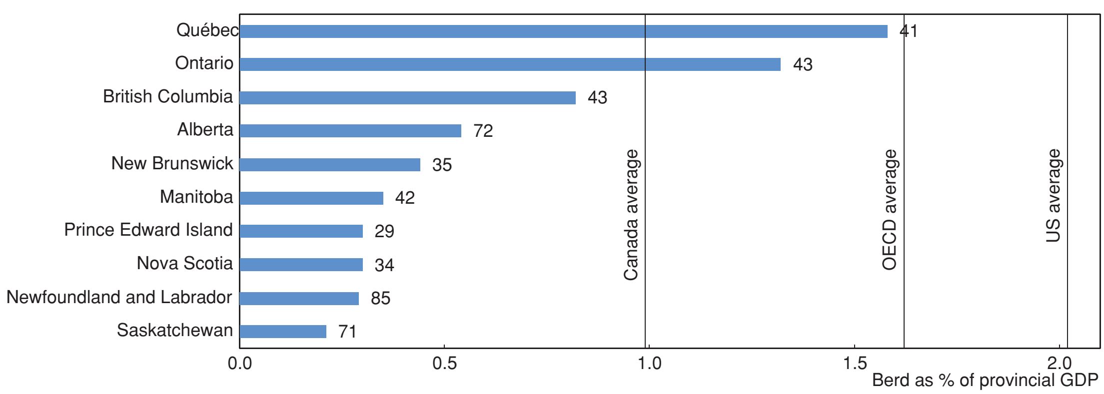
reflect a level of per capita income that is "too high" owing to resource rents, boosting the denominator of the BERD-intensity ratio. But the presence of resource rents might itself dull the drive to innovate, by attracting labour and capital to less BERD-intensive sectors like mineral exploitation, refining and transportation.

Regional differences within Canada likewise suggest a link between innovation and resources. Per capita incomes are higher in the resource-rich provinces of Alberta, Saskatchewan, and Newfoundland and Labrador, owing to resource rents, but BERD is higher in the central manufacturing and business services-based provinces of Ontario and Québec (Figure 1.8). The latter two provinces are still more heavily exposed to resource-based industries than the typical OECD country; otherwise their BERD intensities might be even closer to the OECD average. A feature of the low-BERD jurisdictions is that their resource industries are able to generate large amounts of GDP without the need for correspondingly large investments in R&D (Freedman, 2011). Cross-provincial income disparities, as measured for instance by the Gini coefficent of income inequality (*OECD Regional Outlook 2011*), have been growing due to strong relative price shifts coupled with unequal resource endowments. Addressing this problem may require extra efforts in building human capital and innovation capacity in the resource-poor regions.

Figure 1.8. **BERD intensity in Canada**

By province, 2008



Note: The figure at the end of each bar is the province's productivity level (CAD per hour worked) in the business sector (goods and services) in 2008.

Source: Statistics Canada.

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International scoreboards

Global rankings provide a barometer of the strengths and weaknesses of national innovation systems, based on consistent methodologies for calculating various performance indices. The latest *Global Innovation Index* (INSEAD, 2011) ranks Canada's innovation capacity favourably and as consistent with its high per capita GDP. Major strong points are the regulatory and business environments, quality of research institutions, non-ICT infrastructure, the investment climate, new businesses, innovation linkages, creative outputs, notably service exports, and business/organisation ICT models. On the other hand, Canada ranks in 54th place in innovation efficiency, indicating an overall poor return in terms of innovation output for the corresponding inputs. Related to this result are very low rankings (roughly 40th or worse) for: energy efficiency of production, gross capital formation (M&E), strength of legal rights for credit (collateral and bankruptcy laws), openness to trade and competition, computer and communications service imports, net inflows of FDI, and resident trademark applications.

The European Commission's 2008 *Global Innovation Scoreboard* (EC, 2009) compares innovation performance in the EU27 to that of 16 other major R&D spenders in the world, including Canada. Three "pillars" of innovation are proposed, supported by the relevant indicators: firm activities and outputs (triadic patents per population, BERD); human resources (S&T tertiary enrolment ratio, labour force with tertiary education, R&D personnel per capita, scientific articles per capita); and infrastructure and absorptive capacity (ICT expenditures per capita, broadband penetration per capita, GERD). Canada ranks second in human resources (though the methodology does not account for the mix of different types of tertiary education, which is unusual in Canada; see Chapter 2), eighth in infrastructure and 18th in firm innovative output.

No other country in the global peer group displays such a wide divergence between human resources/research infrastructure and firm R&D/patenting activity. Germany and the Netherlands manifest an opposite conundrum: relatively weak human resources but strong firm innovation output, although in these countries in-work training is likely to be a very important dimension of human resources not well captured by the indicator.

Policy drivers and barriers to innovation

This section explores major determinants of business innovation so as to identify key innovation barriers that may explain the Canadian paradox and which may be amenable to policy influence.

Economic openness

Openness to trade, capital and labour flows (both inward and outward) reinforces competition – in turn the driver of innovation as a central competitiveness strategy (CCA, 2009). Reducing anti-competitive regulations in sheltered sectors is found to be the second most powerful incentive for increased business R&D spending (Jaumotte and Pain, 2005). Geography can be viewed as both a handicap and an advantage in this respect. Economic integration with the United States offers major opportunities for market expansion, scale economies, knowledge spill-overs and competitive intensity. Mobility of goods and services, capital and labour is high, particularly following the 1980s US-Canada free trade agreement and the 1990s North American Free Trade Agreement (NAFTA). In 2010, three-quarters of Canada's exports went to the United States, and more than half of Canadian manufacturing sales were by affiliates of US multinationals. North-south trade and capital flows across contiguous US states and Canadian provinces are more extensive than east-west integration across the Canadian provinces themselves. The recent economic crisis highlighted the risks of overdependence on one large market, however. The Canadian government is negotiating trade and investment agreements with the European Union and Asian partners, or planning to.

It is frequently asserted that R&D and other high-value-added activities have been displaced to head offices of US multinationals, with a consequent "brain drain" out of Canada and a diminution of Canadian innovative and business prowess ("hollowing out"). Similar concern has been voiced over the fact that of 137 VC-backed Canadian firms whose ownership changed hands in 2006-10, nearly 60% were sold to foreign buyers mainly for their valuable IP, taking Canadian-educated talent with them (CIC, 2011).

However, integrated production chains (notably in automobiles) allow ready access by Canadian affiliates of US multinationals to the latest US technological and managerial know-how. In the auto industry, Canadian affiliates of US auto firms have traditionally been more productive than their US counterparts, mainly through a tradition of innovation in work processes and organisation, despite doing less R&D (CCA, 2009), although this advantage has waned in light of the 2000s terms-of-trade shock (Rao, 2011). Foreign-controlled manufacturing firms in general display higher MFP than their Canadian-controlled counterparts, even after accounting for differences in other firm characteristics (Rao *et al.*, 2008). The resulting benefits in terms of competitive intensity and access to knowledge flows are likely to be diffused more widely, as domestic competitors and suppliers learn by example and strive to catch up (Bergevin and Schwanen, 2011).

To take full advantage of FDI, Bergevin and Schwanen (2011) and CPRP (2008) have recommended that the Investment Canada Act's (ICA) net benefit test for foreign investments, which risks being used as a protective device, should be either removed or the onus shifted to government to prove that a proposed investment is *not* in Canada's interests, with the reasons publicly stated. As announced in the 2012 budget, the federal government is in the process of making targeted improvements to the *Investment Canada Act* to enhance transparency while preserving investor confidentiality. The Ministries of Industry and Canadian Heritage should create procedures to provide foreign investors with timely and binding opinions concerning ICA compliance of prospective transactions (CPRP, 2008). At the same time, ownership restrictions in sheltered sectors, notably telecommunications and broadcasting, need to be lifted in order to get much needed capital, contestability and management talent. This process has already begun: in 2010, foreign ownership restrictions were removed for Canadian satellites and changed to permit greater foreign investment in the air transport sector. Most recently, as announced in the 2012 budget, the federal government is in the process of lifting foreign investment restrictions for telecommunications companies that hold less than a 10% share of the total Canadian telecommunications market.

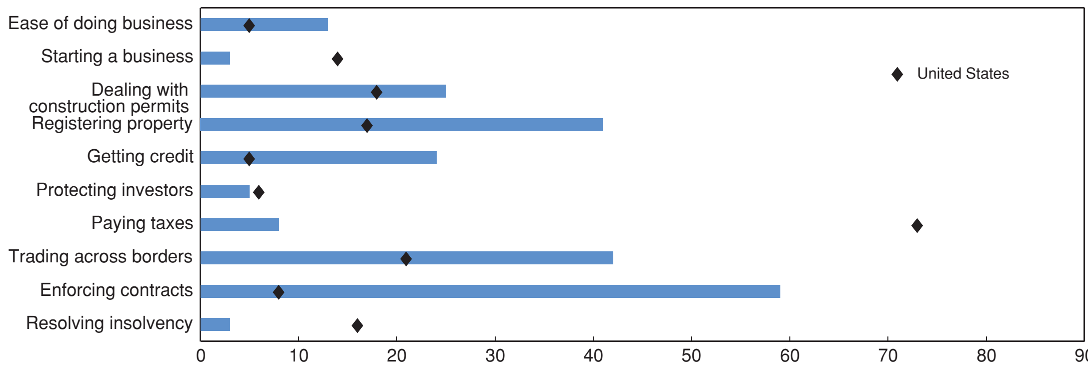
Inter-provincial barriers to goods, services and resource flows reflect a lack of openness internally, limiting market size, competitive pressures and the gains from trade. Amendments to the Agreement on Internal Trade (AIT), agreed in 2009, made it a more effective framework to ensure labour mobility for regulated professions and trades. But implementation is still ongoing.

Entrepreneurship

Entrepreneurial firms are the subset of firms that are growing and innovative. These firms take advantage of technological and market opportunities, and a few grow into global leaders. They also include "gazelles", young firms that experience high growth (OECD, 2010b; ICP, 2012). The World Bank's ease of doing business index indicates many favourable factors for entrepreneurship in Canada (Figure 1.9). The number of days needed to start a business is low, bankruptcy procedures are particularly simple, and paying taxes is easy. On the other hand, the number of days needed to get an electrical connection is higher than in most countries, and enforcing contracts is also difficult. Compared with the United States, it is also significantly harder to obtain credit in Canada owing in part to lenders' collateral requirements, and trade across provincial borders is relatively hampered. Such indicators echo some of the Global Innovation Index rankings.[2] Ease of entry is needed to stimulate competition and innovation, even if only a small number of innovative start-ups (perhaps 2-4%) eventually grow into large firms (IPFSRD, 2011 and MacIntosh, 2012).

Figure 1.9. **Ease of doing business**[1]

June 2011



1. Ranking on the ease of doing business among 183 economies. A high ranking on the ease of doing business index means the regulatory environment is more conducive to the starting and operation of a local firm. This index averages the country's percentile rankings on 10 topics (getting electricity is not shown), made up of a variety of indicators, giving equal weight to each dimension.

Source: World Bank, *Doing Business Database*.

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Successful entrepreneurs seem to have a higher than average propensity for risk-taking (ICP, 2012). Some empirical evidence suggests more cautious attitudes to risk by Canadian as compared with US businesses, however (Box 1.2). In the United States, the prevailing wisdom is that business or professional failure is a valuable learning experience and that entrepreneurs are deserving of second chances. New US business theories are

Box 1.2. **Attitudes to risk and managerial quality**

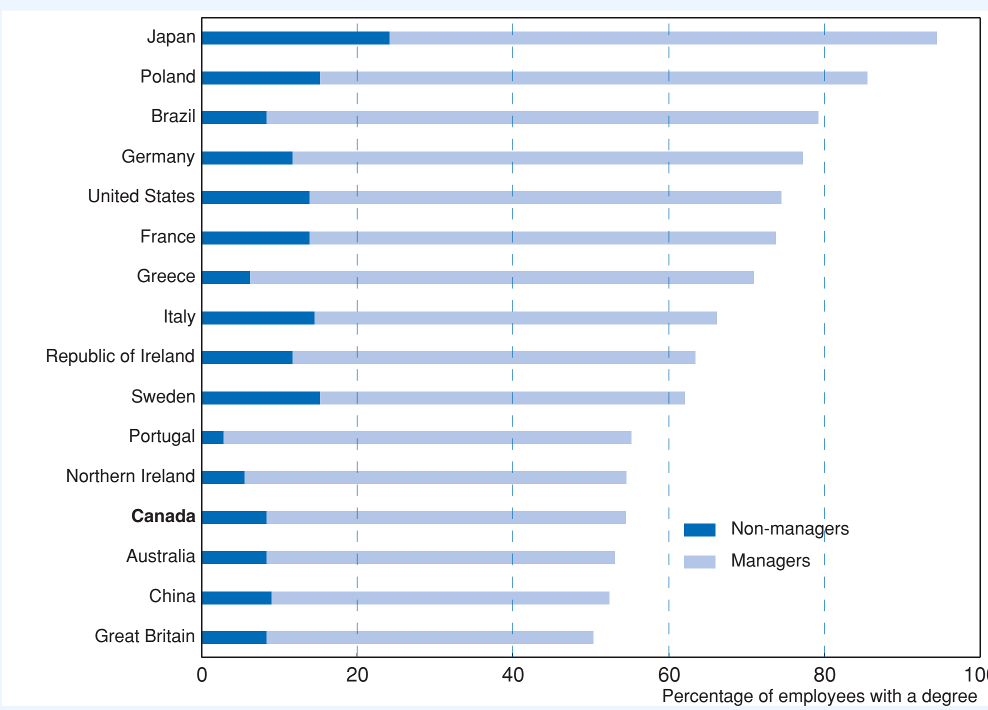
Available business innovation surveys such as SIBS and CIS suggest relatively highly risk-averse behaviour by Canadian managers when undertaking innovation. For example, whereas in Canada, 44% of medium-sized firms reported uncertainty and risk as a major obstacle to innovation, in the United Kingdom the corresponding figure was 36% (McCann, 2010), although this difference is not significant. A recent survey by a major polling firm of a wide spectrum of Canadian and US firms focused on the attitudes of senior executives to assuming business risks associated with growth and innovation (Deloitte Research, 2011). Whereas Canadian executives see themselves as neither more nor less willing to take on reasonable risks than their colleagues south of the border, the level of risk tolerance displayed by the actual decisions that they reported making, filtered by researchers through the heuristics used in arriving at these decisions, suggest that American respondents are 13% more tolerant of risk than the Canadians. The gap widens to 18% when adjusting for the more negative current economic state and future outlook of US respondents in 2011. This result is driven by a much lower R&D rate of participation among risk avoiders in the two countries (70% *versus* 83%), rather than higher R&D intensity among risk takers or a difference in the proportional sizes of these two groups. The survey data also suggest a greater reliance by Canadian firms on government support in order to motivate investments in R&D. US firms indicate a greater responsiveness to an expansion in the availability of risk capital or an improvement in the protections afforded to IP rights. While excessive optimism among US managers has also been documented, and could lead to reckless behaviour, research shows convincingly that a high degree of managerial optimism can lead to more socially optimal levels of innovation, especially when combined with product market competition (Galasso and Simcoe, 2011).

Box 1.2. **Attitudes to risk and managerial quality** *(cont.)*

An international survey and empirical analysis of management quality in manufacturing by Bloom (2011) sheds further light. It finds that firms in Canada, in fact, follow good practices similar to those found in firms in Germany, Japan and Sweden, and better than in most other European and developing countries. However, 22% of Canadian firms are worse managed than the average from Brazil, China and India, suggesting a long tail of Canadian manufacturing vulnerability. US firms outperform Canadian ones by a significant margin. One reason for superior US performance is competition and market discipline: well run firms are rewarded more quickly with greater market share, while poorly managed firms are forced to shrink and exit. According to this author, Canada is not far from the United States in terms of openness of product markets and lightness of labour market regulation, though its higher rate of trade unionisation (36% *versus* 16%) may restrict some management practices. The two countries are also not too dissimilar in ownership patterns, with mostly well managed publicly quoted and private equity-owned firms as opposed to family (inherited) and government managed firms as in some other countries. The one area where Canada appears to lag markedly is in worker and manager education (Figure 1.10 and Chapter 2). The author's estimations show that worker education is as important to management quality as manager education, reflecting that workers often drive innovation and productivity improvements.

Figure 1.10. **Educational attainment of managers and workers**

Bachelor degree or higher



Source: Data have been drawn from Bloom, N. (2011), "Management and Productivity in Canada: What Does the Evidence Say?", *Industry Canada Working Paper Series*, No. 2011-05.

also putting emphasis on "delighting the customer" as the key to corporate survival (as exemplified by Apple) and, in principle, the main driving force of innovation (Denning, 2011). However, according to Roger Martin, Dean of the University of Toronto's Rotman School of Management, Canadian businesses are significantly lagging in adopting such a mindset. In order to improve the innovative capacity of Canadian companies, senior managers need to enhance customer understanding and the pursuit of customer satisfaction.

Entrepreneurship skills are acquired by a process of lifelong learning, but education is an important first step and can be provided at all levels. Innovation/science awards by age group are increasingly popular as a motivational device. At the tertiary level, entrepreneurship education is a rapidly developing field. US business schools are the acknowledged leaders in this area, providing courses in entrepreneurship, small business management and new venture creation with an approach using case studies, business plans, discussions and lectures by business owners and guest speakers. Though similar courses are taught in Canadian business schools, they are not as well developed, and participation is only one-third that in US business schools (OECD, 2010a).[3] The University of British Columbia, nonetheless, offers a course on commercialising technology, which allocates half the seats to MBA students and half to graduate students from science and engineering departments, and also provides access to a network of industry people who serve as guest lecturers; this has contributed to technology transfer (spin-offs) by encouraging a culture of commercialisation on campus (Agrawal, 2008). Beyond formal education, training at work is essential. Ultimately, however, the cognitive and social skills that characterise entrepreneurs do not necessarily bear a causal connection with education or management training, and human capital of different sorts is associated with survival probabilities in start-ups. Attitudes toward risk, moreover, may be largely a function of institutional context rather than culture or training.

Another important route to imbuing society with entrepreneurial dynamism is through continuing immigration and ethnic diversity. It might be argued that economic immigrants are by definition system outsiders and often originate from highly entrepreneurial cultures themselves. They must take risks, be entrepreneurial and work hard in order to advance materially and socially. Research has found that many successful R&D-intensive start-ups have been led by foreign-born entrepreneurs, who are often more pragmatic, frugal and prepared to do what it takes to succeed in commerce (Barber and Crelinsten, 2009). Highly skilled immigrants display similar characteristics to those of entrepreneurs and are for this reason a focus for Canada's immigration programme. First- and second-generation Canadians are prominent in the pool of university-educated labour force entrants, crucial for productivity in the knowledge-based economy. Second-generation Canadians are also much more likely to have a university degree and be employed and less likely to rely on social assistance, and their average earnings are higher than those of young adults of Canadian-born parents.

The federal government recognises both the near- and long-term benefits to Canada's economic growth resulting from skilled immigration. In fact, some immigration programs such as the Federal Business Immigration Program are specifically designed to select experienced investors, entrepreneurs and self-employed immigrants, targeting more active investment in Canadian growth companies and more innovative entrepreneurs. Moreover, under its 2012 budget, the federal government outlined that it will begin to target more active investment in Canadian growth companies and more innovative entrepreneurs under the Business Immigration Program. Nonetheless, given the variable quality of foreigners' current performance – notably reflecting official language proficiency, access to business and professional networks, and cultural adaptability – it is suggested that additional focus could be put in the short term on attracting graduate students to Canada and giving them easy access to work visas following receipt of their advanced Canadian degrees. This, though, may become more difficult as economic opportunities multiply in China, India and elsewhere.

A greater inclusion of women in the ranks of managers and owners could also tap into latent talent. Statistics indicate a mediocre performance in this regard, however, with the share of individually owned enterprises with a female owner varying between 20% and 40% across OECD countries. Furthermore, empirical evidence suggests that enterprises founded by women tend to have lower levels of innovation activity relative to enterprises founded by men. Recent OECD research has found that, while part of the gap in the propensity to innovate across gender groups may be explained by the disparity in the characteristics of the enterprises owned by women relative to men, there is increasing evidence that the difference may be largely attributable to the owners' characteristics. A number of barriers to innovation activity for women entrepreneurs have been identified: *i)* an education and careers experience gap in certain innovative or high-tech fields; *ii)* an equity financing gap; and *iii)* a networking gap, generated by the low numbers of women entrepreneurs in innovation-intensive industries and by the low visibility of successful innovative women. Policies should be used to address such barriers.

Women could also help fill the looming shortages in STEM and other advanced technical skills, but they are vastly underrepresented in the STEM disciplines. Women's scientific inclinations should be nurtured at an early age via enlightened teaching, science clubs, contests and the like that encourage girls to participate.

Fiscal incentives

Canadian government support to business innovation is among the most generous among OECD countries, but its composition is atypical. Indirect funding *via* generally available R&D tax credits is the second highest among a sample of OECD countries, after France, whereas direct funding of business innovation is one of the lowest (see Figure 12, Panel A in Assessment and recommendations). This reveals a choice by the Canadian authorities to stress forms of funding that apply neutrally, so as to establish a "level playing field" and a presumably more efficient "let markets decide" approach to R&D resource allocation. The government thus attempts to avoid "government failures", notably those that require "picking winners" by means of grants. However, the downside of such a policy is a lack of targeting and possible tax deadweight costs. Moreover, the playing field is not truly level: small, Canadian-owned firms are substantially favoured in the design of the tax credits over foreign-owned and large firms. It is also possible to lower the risk associated with picking winners by means of competitive grant procedures.

R&D tax credits

The Scientific Research and Experimental Development (SR&ED) tax credit is one of the most expensive tax expenditures in Canada (costing CAD 3.6 billion for the federal government in 2011 and an estimated CAD 1.5 billion for the provinces and territories). Its high cost reflects the high rate of subsidisation rather than intensity of business R&D activity. The general federal SR&ED tax credit rate is currently 20% of eligible R&D performed in Canada. Unused credits may be carried back up to three years and forward up to 20 years. For small Canadian controlled private corporations (CCPCs), the credit increases to 35% (up to a maximum of CAD 3 million in qualified expenditures), in which case it is also refundable.[4] Almost all provinces top up the federal tax credit with their own variants (Table 1.6). The common base includes both capital and current expenditures plus "overhead" costs (of up to 65% of wage costs, which is generous) and most R&D contracts with tertiary institutions (except for Québec which counts only wage costs plus 50% of such contracts). On top of these investment tax credits, qualifying SR&ED expenditures are fully deductible from taxable income, and unused deductions may be carried forward indefinitely. Since R&D current and capital spending may be considered to be an investment, allowing its immediate expensing (rather than capitalisation) provides a significant benefit to firms.

Table 1.6. **Federal and provincial tax credit rates**

Per cent

Provinces	Provincial tax credit	Federal plus provincial[1]	
		Small CCPCs	Other firms
Alberta and British Columbia	10	42	28
Manitoba	20	48	36
New Brunswick, Newfoundland and Labrador, Nova Scotia, Saskatchewan and Yukon	15	45	32
Northwest Territories and Prince Edward Island	0	35	20
Ontario (small/large firms)	10/4.5	42	24
Québec (small/large firms)[2]	37.5/17.5	48	27

1. The federal credit is 35% for small CCPCs (Canadian-controlled private corporations) and 20% for other firms. The base for the federal credit is reduced by the amount of provincial credits.
2. The Québec credit is paid on wages and salaries plus 50% of contracts. The federal-provincial rate is expressed as a percentage of R&D costs eligible for the SR&ED credit.

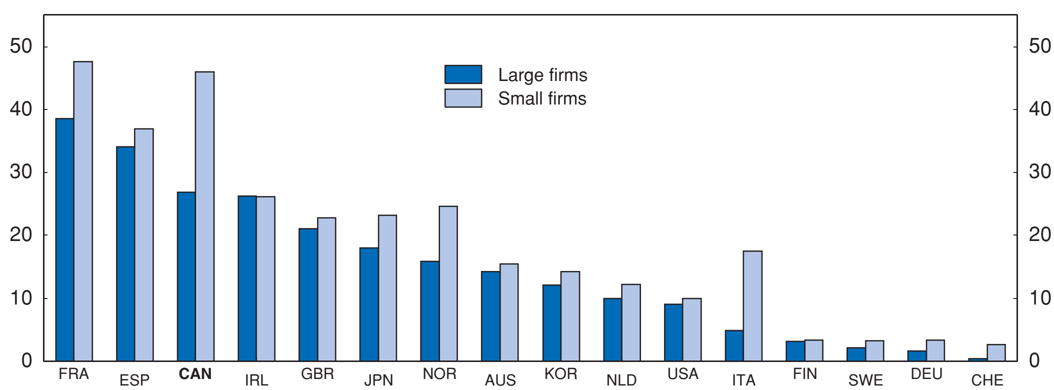
Source: Independant Panel on Federal Support to Research and Development (2011), *Innovation Canada: A Call to Action*, Ottawa.

The SR&ED credit adds to complexity in the tax code, raising administrative and compliance costs. Activities eligible for the SR&ED tax incentives involve systematic investigation or search carried out in a field of science or technology by means of experiment or analysis. In general, three broad categories of activity are eligible: basic research, applied research, and experimental development. The definition of SR&ED for income tax purposes is largely consistent with the OECD definition of R&D, as presented in the Frascati Manual (OECD, 2002), and is generally consistent with the definitions in other industrialised countries for their R&D tax incentives. Firms must demonstrate that their R&D activities meet this definition. The SR&ED tax incentive program is administered by the Canada Revenue Agency (CRA), which sets out three qualifying conditions: *i)* the activity must generate information that results in scientific or technological advancement; *ii)* the outcome must be unknown in advance of undertaking the activity; and *iii)* the activity must be carried out by qualified personnel and involve systematic investigation through experiment and design (Parsons, 2011). For small firms, complexity in the SR&ED program may lead them to use the services of SR&ED related consulting services, whose high contingency fees reflect the generosity of the tax credit. The 2012 budget announced a study of contingency fees charged by tax preparers. It is estimated that small firms spend on average 14% of their tax credit in compliance costs, while large firms pay around 5% (IPRFSRD, 2011).

The difference between the small and large firm effective subsidy rates is the largest in the OECD (Figure 1.11), exacerbating the incentive to stay inefficiently small. Moreover, the refundable tax credit offered to small CCPCs is renewable without limit, encouraging entry though giving rise to a soft budget constraint that could keep some companies going beyond a point where they should have exited, as they do not need to earn a market return in order to get revenue. Furthermore, firms undertaking R&D have access to a wide range of federal and provincial support programmes and frequently obtain funding for the same project from more than one, creating a "stacking" of R&D support. In 2007, 70% of all small firms received financial assistance amounting to 40-50% of their spending on R&D and 10% received more than 50% (RFSRD, 2011). This implies a high effective tax rate on earnings above the income qualifying threshold of CAD 500 000. There is also the question of how well the enhanced subsidy targets firms most in need of support. The age of a company (start up or mature) may say more about its problem with access to capital than its size (OECD, 2006; Parsons, 2011). The best response to market failures that may adversely affect SMEs is unlikely to be through size related tax measures (Parsons, 2011).

Figure 1.11. **Tax subsidy rate on investment in R&D**[1]

2009, percentage



1. The data include income tax deductions and R&D tax incentives provided by sub-national governments. The element of income tax deductions corresponding to an economic depreciation allowance is not a subsidy and thus not included.

Source: Department of Finance (2009), Tax Expenditures and Evaluations 2009, Part 2, "An International Comparison of Tax Assistance for Investment in Research and Development", Ottawa.

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A further problem is the suspected deadweight cost of the tax credit for large firms, which may have performed the R&D in any event (Baghana and Mohnen, 2009, suggest such an outcome in Québec). Nonetheless, the broad literature on stimulative effects of R&D credits shows that they do effectively increase the total amount of R&D spending, though small firms may be more responsive to the price signal, possibly reflecting that they are more concentrated in R&D intensive sectors (Corchuelo and Martinez Ros, 2009). It has been suggested that use of an incremental based R&D credit increases large firm responsiveness and from that perspective may be preferable to a volume-based credit (Baghana and Mohnen, 2009). While incremental tax credits are more efficient for government (minimising the amount of "subsidised" R&D that would have been undertaken even in the absence of support), they are also more complex to implement. The general OECD trend has been to make R&D tax incentives more generous and simpler to use (OECD, 2010e).[5]

The key issue regarding the SR&ED is not the extent of financial-market failure but the level of subsidisation that is justified by externalities (*i.e.* the efficient effective tax credit rate). The "net benefit" of the SR&ED tax incentive has been calculated to be positive (Parsons and Phillips, 2007), but wide ranges of uncertainty around parameters used make this calculation highly uncertain (Parsons, 2011). Furthermore, the analysis was based on an "average" federal tax credit, so that the expected net return for the much richer tax credits for CCPCs might well be negative. The Jenkins report concluded that the calculation of the net benefit is not sufficiently precise at this time to permit a benefit-cost ranking of the government's various business R&D support programmes, though that remains a worthy goal (IPFSRD, 2011). A preliminary analysis by Lester (2012) provides just such a ranking and finds that whereas the general SR&ED credit rate is around the optimal level, the refundable credit and Industrial Research Assistance Program (IRAP) (the major grant programme targeting SMEs) may not be, as their beneficial spill-overs (*i.e.* the social return less the private return of the additional R&D induced by the subsidy) are strongly outweighed by the economic cost of financing the assistance with taxes that harm economic performance plus the costs of administering and complying with the programmes.[6] His calculations show that the negative net benefit of the refundable SR&ED can be eliminated if the subsidy rate falls to 18% and administrative and compliance costs fall by 25% and 50%, respectively.

The ongoing dramatic reduction in the statutory federal corporate income tax (CIT) rate has not changed the unit value of the SR&ED credit, but made it less likely for large firms to fully benefit from the credit in the year in which the costs are incurred. Hence, they face larger "tax risk" that they must have sufficient tax payable in order to fully benefit from the credit (since carrying unused credits forward is not costless). Such tax risk may have the advantage of "targeting success" (IPFSRD, 2011), though only in a limited sense, as large businesses unable to use the credit are those that make consecutive losses until they finally fail. Nevertheless, the 2012 federal budget proposes, as of 2014, a reduction in the general SR&ED investment tax credit rate from 20% to 15%, in line with the recent federal CIT reductions (from 22% in 2007 to 15% in 2012) (Government of Canada, 2012). The small-firm tax credit remains at 35%; being refundable, it is unaffected by the CIT reductions. This enlarges the gap with large firms, however. Also, the general rate would appear to be now too low from the viewpoint of social welfare. The lower CIT rate, if anything, might justify a larger subsidy insofar as it reduces the deadweight costs of taxation.

The Jenkins report (IPFSRD, 2011) recommended that the enhanced refundable credit apply to wage costs only (as is already the case in Québec). Such streamlining of the base would help to reduce small-firm compliance costs, though at the peril of creating a new distortion in favour of labour-intensive small firms, which may be less innovative. The panel, nevertheless, recommended maintaining capital expenses in the base for large firms, where they are likely to be a more significant part of R&D activity. It also called for the credit for small firms to be made partially refundable, with this change to be phased in. Refundability for small firms may be justified insofar as they have difficulty getting outside funding for their R&D efforts, whereas non-refundablility would help to reinforce small firms' motivation to succeed. Making the small firm credit partly refundable could help to balance this trade-off. However, partial refundability would result in firms not being able to claim the SR&ED tax credits in the year that they are earned and in ongoing growth of unused tax credits until such time that the firm earns a return.

The 2012 federal budget proposed to exclude capital costs as of 2014 from the expenditure base of the SR&ED, but for *all* firms, large and small, on the argument that the rules regarding the eligibility of capital expenditure are the most complex for businesses to comply with (Government of Canada, 2012). However, this multiplies concerns about distorting technology choices due to non-neutrality of the base. It also reduces the effective subsidisation of large firms beyond that already implied by the cut in the general tax credit rate. As just 75 larger firms perform about half the R&D in the economy, and 25 perform one-third (IPFSRD, 2011), the large drop in their effective subsidy rate below the presumed optimal level poses significant risks to BERD. Even so, several other OECD countries have credit schemes that focus only on R&D wages, presumably as a way to control public cost or boost high skilled employment. The budget also lowers the cap for eligible overhead costs and removes the profit element from covered contract costs.

In conclusion, it would be preferable to lower the small-firm rate toward the general rate, while also reducing small-firm administrative and compliance costs. The general rate should be kept at 20% and capital should stay in the qualifying expenditure base (though overhead and contract costs should be streamlined as planned). As the small-firm credit accounts for around 45% of the total federal SR&ED tax expenditure of CAD 3.6 billion, reducing it from 35% to 20% would yield fiscal savings of nearly CAD 700 million per year. Even going only part way to this goal would address both fiscal and economic efficiency considerations. Liquidity constraints could be best addressed by retaining (partial) refundability.

Grants

Fiscal savings from these reforms could be used to shore up targeted business grants and to provide vouchers for use in academic contracting. The voucher approach has been successfully piloted in Alberta and used extensively outside Canada, notably in the Netherlands, and it is effective because the fiscal spending is controllable and directly stimulates technology transfer, while leaving full autonomy to firms in defining projects.

Direct subsidy programmes in the form of grants, subsidised loans, provision of services and public procurement of research or innovative products are numerous at both federal and provincial levels. They are geared predominantly to small businesses, on the grounds that they lack internal resources and face difficulties in obtaining external funding. These programmes are individually small and fragmented and even cumulatively are of a very small scale. They remain for the most part unevaluated by government or other researchers. Consolidation and co-ordination could at once reduce administration costs and help businesses to understand what help is available and access it.

One scheme that stands out as an exception to this general picture is the IRAP, which is the largest programme at 15% of all granting, yet still small by international standards. The 2012 federal budget doubled the programme's contributions to small and medium-sized businesses, using part of the savings from the streamlining of the SR&ED. It provides for funding for R&D and various other innovative activities, including marketing and organisation, which are not provided for in the restricted base of the R&D tax credit, along with commercialisation advice to small businesses. However, such advice is very expensive and could reduce the net benefit of the IRAP (Lester, 2012). Moreover, while outsourcing the advice function bolsters the skill set of decision makers, it does not provide firms with the mentoring associated with venture capitalists (below), and these advisors do not have strong financial incentives, since they are fixed rather than residual claimants (MacIntosh, 2012). Direct funding also lends itself much more easily to political interference, and one safeguard could be to target such funding on sectors of maximum beneficial social spill-overs. IRAP is broadly patterned on the US small-business innovation research (SBIR) programme, which in turn is widely credited as being an important part of the US small-firm innovation success story and development of the venture capital (VC) market (OECD, 2011b). SBIR-like programmes have been gaining popularity in other OECD countries as well. However, the dominant OECD pattern has been one of decreasing reliance on grants and increasing use of tax credits (OECD, 2010e).

The Jenkins report (IPFSRD, 2011) provided an original contribution in attempting to evaluate the main grant programmes' effectiveness. It recommended using the savings from streamlining the small-firm SR&ED to expand IRAP and commercialisation vouchers, while consolidating the myriad of smaller programmes along several distinct "product lines".[7] The report also proposed an arms-length federal agency – the Industrial Research and Innovation Council (IRIC) – to advocate for a whole-of-government approach to innovation, and to fund, oversee and deliver the various business-support programmes in close collaboration with provinces and business. As the report states, governments further need to evaluate the performance of tax-credit and direct-support programmes to assess their comparative cost-effectiveness in stimulating R&D as a guide to future resource allocation. It will thus be important to build federal capacity to undertake such evaluations.

Demand-side policies

Many countries have noted that a significant challenge for innovation is often not the lack of knowledge or technology, but rather the lack of a receptive market for these innovations. Some Canadian experts argue for a broadening of demand-side, sector-specific support policies as the priority for public policy to promote innovation (Côté and Miller, 2011). This is particularly the case for markets with important public-good characteristics, *e.g.* in environmental, health and other public services. The OECD has recognised that supply-push policies may be ineffective in isolation, and action on the demand side is needed to complement them (OECD, 2011c). Demand-side policies have the added attraction of relatively low costs, depending on their design, in a context of heavy pressure on public resources. Policies to foster demand for innovation – such as innovation-oriented public procurement, standardisation of platform technologies to stimulate firm entry and network effects, taxes or subsidies notably in the environmental area to correct for externalities – are comparatively underdeveloped in Canada.

The Jenkins panel report supported using public procurement to bolster innovation, particularly for SMEs. Whenever feasible, procurement tenders should be framed in terms of needs to be met or problems to be solved, rather than of detailed technical specifications that leave little scope for innovative proposals (IPFSRD, 2011; OECD, 2011c). In health sciences and green innovation, social spill-overs might be greatly enhanced by supporting promising new platform technologies such as hydrogen cell technology, genome- and nano-technologies that can spawn as yet unimagined applications, rather than specific ones such as wind power, biofuels, etc. The federal government should work collaboratively with provincial and municipal governments – municipalities are major procurers for infrastructure projects, and provinces are responsible for health-care spending, where there is likely to be substantial potential for innovative procurement – toward the same end. It would also be well to open tendering to foreign firms (even if not required by international trade agreements), in order to stimulate competition and knowledge transfers. It is also important to make transparent the amount of implicit subsidy involved.

Financing

Financial markets in Canada are highly developed, yet several indicators suggest room for improvement. The median cost of equity (risk-free rate + equity risk premium) has been higher for Canadian than for US firms by 50 basis points after adjusting for firm size and industry structure, despite nearly equal risk-free interest rates (Witmer and Zorn, 2007). Canadian firms may likewise be forced to maintain higher profitability than US firms to attract footloose foreign capital (Freedman, 2011).

Banking

The Canadian banking system is well regulated and supervised, and profitability is high. At the same time, there may be a trade-off between banking-system stability and economic dynamism (OECD, 2010c). Canadian banks' prudence in lending served them well in the global economic crisis, but financial innovation could also have significant benefits for consumers (Lerner and Tufano, 2011). Canada's banking culture also implies a preference for collateral-based lending; hence, domestic mortgages account for a share of bank assets that is high by international standards (OECD, 2010c).

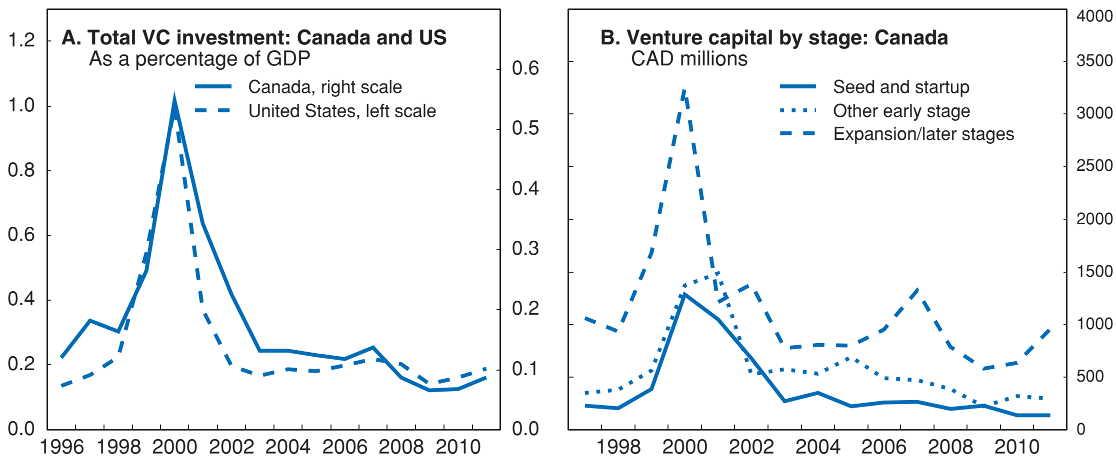
Banks are not involved in early-stage seed-capital funding for innovative start-ups because intangible investments by definition lack a physical form that can be collateralised. Furthermore, the entrepreneur may have no track record and few product lines so that cash flow deficits and surpluses across multiple products cannot be used to offset each other. Business surveys reveal that SME financing is more problematic in Canada than in the United States, and there is evidence of a greater reliance on loans from family and friends, suggesting a lower availability of formal debt financing (Leung *et al.*, 2008). Whereas 29% of all business loans in the United States go to SMEs, only 17.5% do so in Canada (OECD, 2012c). This may reflect the fact that US lenders effectively price risk whereas Canadian lenders follow a more uniform pricing policy. Thus, riskier SMEs benefit by being able to obtain credit more cheaply, but less risky ones end up paying higher interest rates than they would in the United States (Leung *et al.*, 2008). While its aggregate impact on the cost of SME finance is uncertain, this would still imply a less efficient allocation of capital in Canada.

Securities markets

A liquid and dynamic capital market can provide ample and affordable funding to innovation by spreading risk across many investors. However, severe information asymmetries, exacerbated by the non-rival nature of intangible assets (making innovators reluctant to reveal much of their plans to competitors), lead to a high cost of capital for small and start-up firms, in part to cover the risks of market "lemons" (Hall and Lerner, 2009). Venture capitalists can be enticed to take the high risks of funding unknown start-ups by relying on their own entrepreneurial and industry experience for monitoring, and even then only under the prospect of lucrative exits in the form of initial public offerings (IPOs) or mergers and acquisitions (M&As). Large established firms tend to prefer cheaper internally generated funds for their R&D rather than external finance.

In both the United States and Canada, stellar growth of VC in the two decades prior to the global financial crisis was associated with attractive exit opportunities for venture capitalists, which in turn was a function of buoyant stock markets (Figure 1.12, Panel A). Nevertheless, Canadian VC remained less than half as large (in proportion to its GDP) as its US counterpart, and nearly one-third of all investors in that market are in fact US-based (Figure 1.13). This partly reflects the fact that the United States is the VC originator and

Figure 1.12. **Trend in VC investment, USA and Canada**

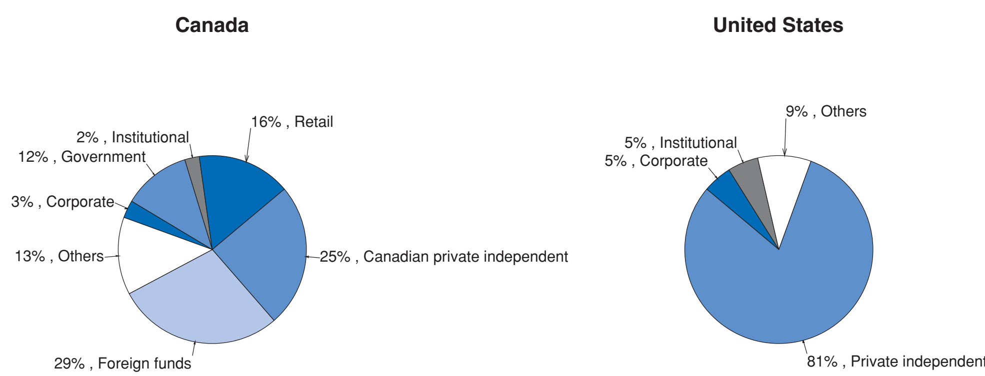


Source: Canada: Thomson Reuters VC Reporter; United States: PricewaterhouseCoopers/National Venture Capital Association MoneyTree; OECD (2012), *Financing SMEs and Entrepreneurs 2012: An OECD Scoreboard*, OECD Publishing. *http://dx.doi.org/10.1787/9789264166769-en.*

StatLink http://dx.doi.org/10.1787/888932618120

Figure 1.13. **VC funding sources in Canada and the United States**

2011



Source: Thomson Reuters for the Canadian Venture Capital and Private Equity Association.

StatLink http://dx.doi.org/10.1787/888932618139

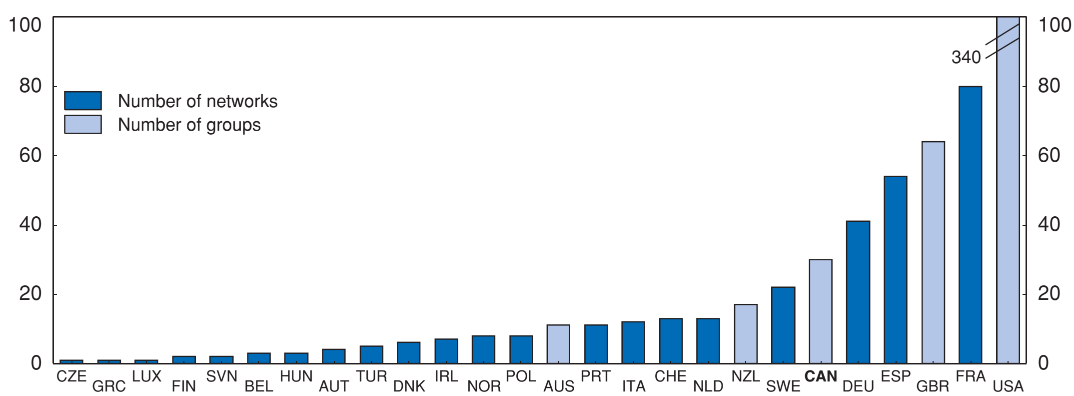
leader, but it could also be related to a lack of experienced venture capitalists, entrepreneurs and a well-functioning ecosystem in Canada. However, the US-Canada gap seems to be driven by two outliers, Massachusetts and California, suggesting a high degree of path dependence in this market. Expressing VC investments as a percentage of BERD virtually eliminates the gap between the two countries. This suggests that the Canadian VC market is itself limited by fundamentally weak business innovation and/or that the lack of VC financing could be contributing to Canada's low BERD ratio.

International experience shows that venture and other start-up forms of capital are important enabling factors for business innovation, as well as *vice versa* (Lerner, 2009). VC markets everywhere collapsed in the aftermath of the "dot.com" bubble and have languished since the 2007-09 financial crisis. VC funds have at the same time refocused their attention on late-stage start-up funding, which is less risky (Figure 1.12, Panel B). The durability of the VC model can be questioned, given that it is apparently dependent on equity-market bubbles to score occasional big wins and that only a tiny share of companies (1 or 2%) get VC funding. Indeed, the VC solution to the problem of financing innovation has its limits: it tends to focus only on a few ("hot") sectors at a time, with minimum size too big for some start-ups, and it is very hard to establish as it requires at least three interacting institutions: investors, experienced venture fund managers and a deep market for IPOs (Hall and Lerner, 2009). Nevertheless, the contribution of VC funding to employment and value added has been very much out of proportion to its small size (CVCA, 2011).

The decline of the VC sector has shifted policy attention to angel investors, who typically operate at even earlier stages than venture capitalists and also provide the hands-on support that nascent entrepreneurs need. Angel investors tend to be experienced "serial entrepreneurs" who have been successful themselves and provide valuable mentoring and patronage as well as financial support to start-ups in an alignment of philanthropy and self-interest. Although data are sparse, reflecting the largely informal nature of angel investing, estimates are that angel and venture capital investments are roughly equal to each other in size in both the United States and Canada, though, looking at only seed within and early stages, angel capital is much bigger (OECD, 2011f). So far, the angel market in Canada is developing, and angels are increasingly investing through groups and becoming more visible (Figure 1.14). A good source of angels might be Canadian entrepreneurs returning from the United States, bringing back valuable experience gained there.

Figure 1.14. **Business angel networks/groups**[1]

2009



1. Business angel groups are formed by individual angels joining together with other angels in order to evaluate and invest in entrepreneurial ventures. The angels can pool their capital to make larger investments. A business angel network is an organisation whose aim is to facilitate the matching of entrepreneurs with business angels.

Source: OECD (2011), *OECD Science, Technology and Industry Scoreboard 2011.*

StatLink http://dx.doi.org/10.1787/888932618158

Subsidies to innovation finance

Significant failures in the market for innovation finance have been used to justify public intervention, though such measures must be carefully designed and subsequently evaluated, given a strong risk of unintended consequences (Lerner, 2009). Canadian governments provide two main types of support. The first is federal and provincial tax credits to retail investors in venture capital (VC) or angel funds. The main ones are Labour-Sponsored VC Corporations (LSVCCs). Retail investors can claim a credit on their federal income tax equal to 15% of their investment in such funds (up to a limit). Funds eligible for this tax credit can be invested in a Registered Retirement Savings Plan (RRSP), and so are also eligible for that tax deduction as well. Provinces often top up the federal credit generously. Ontario has recently discontinued its LSVCC credit on the basis of a cost-benefit analysis. British Columbia has introduced large tax credits for angel investors, allowing individual investors to claim personal tax credits of up to CAD 60 000 per year. The British Columbia government claims that each tax dollar of subsidies calls forth many more in the form of private investment and eventual new tax revenues (Hellman and Schure, 2010). This may be an overestimate, because the analysis does not consider all other government support received by these businesses or attempt to measure the incremental value added by the B.C. tax credit, and also because innovative firms typically employ people with good labour market opportunities.

The second form of support is through direct federal government involvement on the supply side of the risk-capital market via incubators, seed funding, loan guarantees and the like. The main vehicle for such support is the Business Development Bank of Canada (BDC). The BDC plays a leadership role in delivering financial and consulting services to Canadian small business, with a particular focus on technology and exporting. To take advantage of financial markets, the BDC increasingly co-finances specific projects alongside private VC firms and also invests in VC "funds of funds".

Altogether public funding (*i.e.* non-private independent, non-foreign) represents nearly half of the entire VC market in Canada. One-fifth is direct government investment (Figure 1.13). This is a very large share that does not seem to bode well for a sustainable market and exposes the government to financial risks, notwithstanding the supposed alignment of public and private incentives by way of design. There is evidence that it introduces distortions into the VC market. In the case of the LSVCCs, these distortions include: retail investing in VC funds for tax-planning purposes rather than for the long term; goals extending beyond making the best possible return for investors; poor governance structures (organised as perpetual corporations rather than as limited partnerships with 10-year lifespans as are most private VC funds); absence of strong incentives for managers, with inefficient constraints on investments; and a lack of transparency and effective performance review by retail investors, as institutional investors like pension funds potentially able to exercise effective oversight are excluded (MacIntosh, 2012; Cumming, 2007).

Such features give rise to negative returns net of management fees and may crowd out private credit supply unable to compete with heavily subsidised credit, adding indirect costs of crowding out to the direct costs of tax subsidies (Cumming, 2007). That is, tax subsidies enable LSVCCs to outbid other VCs for investee companies, driving deal prices up and market returns down, discouraging private entry. Insofar as the largest LSVCCs tend to serve non-commercial goals like regional development and fund only very little actual innovation (MacIntosh, 2012), this attenuates the actual extent of crowding out they cause, though they still distort capital allocation in the market as a whole. An empirical study of Canada's public venture capitalists has shown that they underperform private venture capitalists, and while this would not necessarily be worrying if the publicly funded investments are truly marginal, it may at least in part reflect the crowding out of more productive private capital (Brander *et al.*, 2008). The BDC, for its part, as a crown corporation, is technically immune from political interference; however, it is ultimately accountable to Parliament and the Minister of Industry, and its activities reveal a strong regional bias, with very poor returns for its subsidiary BDC Venture Capital (MacIntosh, 2012).

While recognising the weak state of the VC market, the Jenkins report recommended boosting the resources of the BDC further to support the development of larger-scale, later-stage funds in support of the private VC and equity industry, thereby hoping to catalyse a "critical mass" that is necessary for the market's efficiency. The report also recommended BDC co-funding with angel investors on a "side-car" basis (*i.e.* where private partners make all the decisions). The 2012 federal budget made available an extra CAD 500 million in funding to VC support, including CAD 100 million through the BDC and an additional CAD 400 million in new funding (with details as to programme design and implementation to come).

Government can indeed help develop the market through co-investment funds in which private investors make the investment decisions, but its involvement should be on a strictly temporary basis, as in the case of the former Israeli Yozma fund. Such funds need to partner, rather than compete, with private VC funds, while bridging the gap when the market fails due to structural impediments (Cumming, 2007). Following the examples of the successful US SBIR programme and the Israeli Yozma fund, the government's investment could be guaranteed a modest rate of return on the upside in exchange for sharing in the downside risks, thereby leveraging private returns. More critically, federal and remaining provincial tax credits to retail investors in the LSVCCs should be withdrawn and the entry of pension funds into the VC market encouraged. More could be done to attract US VC funds as well, which should find Canada attractive not least because proximity is important for monitoring by investors. In this respect, it should be noted that the federal government has removed major tax barriers to private equity (OECD, 2010c), including narrowing of the definition of taxable Canadian property which eliminated the need for tax reporting of dispositions by non-residents of many equity investments. Finally, national angel associations could benefit from some government support, but preferably non-financial insofar as these tend to be wealthy individuals (OECD, 2011f).

Accounting rules that enhance investment transparency, notably by further improving the reporting of intangible investment valuations, would greatly facilitate institutional investment in VC (Cumming, 2007). Continuing improvements in financial reporting are likewise useful to enterprises engaged in innovative activity (OECD, 2010b). Government can assist this process by identifying and disseminating standards of best practice for the reporting of information on intellectual assets that can help investors assess future earnings and risks associated with investments in innovating firms. This would not only ease information asymmetries but also strengthen the exercise of ownership rights, subject management and boards to greater discipline and make intangibles valuation more efficient (OECD, 2012b).

Skills

A critical question for policy makers is to what extent public support for research and innovation (public or private, grants or tax incentives) bids up researcher wages and entails wasteful duplication and/or non-productive research. How can wage premia that are necessary for signalling desired supply responses (in education and training systems) be distinguished from such wasteful forms of wage push? Jaumotte and Pain (2005) found that goals like raising R&D intensity were bound to fail unless bolstered by measures to increase the supply responsiveness of R&D skills. With large numbers of baby boomers nearing retirement and educational attainment not rising as rapidly as elsewhere (Chapter 2), this becomes more of a risk, especially as governments are boosting R&D funding to remain competitive against innovating OECD and low cost non-OECD competitors alike.

What skill mix is required? On one count, there are four main functional skill levels: management, R&D, sales/marketing and production (Hanel, 2008). The relative importance of each type of skill depends on the nature of innovation (product, process, organisational or some mix; revolutionary or incremental, etc.), sector (manufacturing or services), firm size (small or large) and ownership (domestic or foreign). Surveys show that SMEs prefer a broader skill set than that offered by PhD graduates when hiring R&D employees. Wage premia are another indicator. Knowledge workers are needed both in production and in R&D, though to a much greater extent in the latter. It is presumed that knowledge-worker skills will be mainly associated with the first three functions. Their wages comprise the bulk of innovation expenditures, together with investments in ICT and other capital with high technology content.

R&D skills are perhaps the most portable of all four and the most important for new-to-market innovations. Firms can obtain them by hiring recent university or college graduates with the latest technical knowledge, or by providing in-house training. Technology transfer is another way in which firms can access such skills, albeit indirectly, typically by purchasing other researchers' output via contracting, leasing rights to others' intellectual property (or else purchasing their patents outright), collaborating in research, or making efforts to benefit from knowledge externalities more broadly. The SIBS showed that Canadian firms are significantly more likely to train workers in-house than to hire recent graduates of tertiary institutions or to collaborate with public research institutions.

High-tech manufacturing and knowledge-intensive services are a relatively small part of Canada's total production. This is likely to curb the demand for R&D skills, implying smaller wage premia for R&D-related skills than in some other OECD countries (Chapter 2). Indeed, notwithstanding the high quality of basic research and the magnitude of business-directed supports, employer demand for knowledge workers or purchases of their output appears disappointing. For instance, PhDs, of which there are proportionately fewer than in the United States, suffer unemployment rates three times as high as south of the border (OECD, 2010d). The science and technology share of total employment is relatively large, without producing correspondingly high innovation output, raising the possibility of underemployment of their skills. There is likewise still too little business collaboration with academics, despite multiplication in recent years of public grant programmes to encourage academic-business linkages. This suggests weak business demand also for the outputs of academic research, even while "supply-push" is being ramped up by various public outreach programmes (centres of excellence, incubators, student internships, etc.). Other disincentives or barriers appear to be at play.

Management is a key skill required for entrepreneurship, which plays a central role in stimulating firm entry and innovation (OECD, 2010a). Case studies of R&D-intensive firms that fail despite sound ideas and public support have pinpointed a lack of management and commercialisation skills as being most often the critical factor in their failure (Barber and Crelinsten, 2009). Thus, these can be suspected of being the key missing skills required for boosting innovation in Canada, as already noted. In part, this is because most innovators have a science and technology background. Indeed, in many smaller firms, notably innovative start-ups, one person (the inventor/innovator) will embody all four functions, all too often imperfectly. By the same token, they lack the knowledge of how even their excellent ideas can be commercialised. Finding the right contacts to line up financing and market interest is another critical feature of effective management.

Innovative workplace organisation (a function of management and worker skills alike) is very likely to be required to boost the creativity of the firm's workforce (OECD, 2011a). Research shows that Canadian manufacturing firms that were better able to adjust to the 2000s exchange-rate shock and maintained their production in the home market excelled chiefly in terms of flexible workplace management practices (Baldwin and Yan, 2010). The most important features appear to be staff training and granting them a high degree of autonomy, which encourages creative thinking, self-direction and responsibility. Motivated and engaged workers are the most productive.

Knowledge flows

Patent and copyrights

The non-rivalrous and intangible nature of knowledge (at least codified) makes it easy to copy and steal, and hard to value. This can be partly overcome by assigning legal property rights to it, for example via patents, trademarks and copyright. The main alternative to legally protecting IP is often secrecy, which may be socially less beneficial. The market for patents, in particular, has important efficiency aspects. One is that innovation is encouraged by enhancing creators' ability to appropriate commercial or other benefits flowing from IP. A second is that it allows a cleaner separation of R&D and commercialisation functions via trading, helping in this way to fill the management skills gap. In so-called vertical specialisation, an individual innovator or small start-up firm specialising in the generation of IP sells or leases the associated patents to a larger firm that is more adept at commercialisation.

There are well known tradeoffs involved with providing IP protection. One is the possibility that it will be abused so as to create monopolies, diminishing competitive intensity to the detriment of subsequent innovation. Empirical work by the OECD suggests that IP protection is on balance favourable to innovation, nonetheless (Jaumotte and Pain, 2005). Another nonetheless is the use of litigation to generate revenues from supposed infringements of IP by so-called patent trolls. In the high-profile case of Research in Motion, Canadian maker of the popular BlackBerry, patent trolls acquired patents relevant to its device, but never used them, and later sued RIM for a majority of its profits (Cummings, 2007). Such risks can be mitigated by carefully delineating the scope of the patent and the legal remedies available.

Canada appears to be falling behind in the international patent race. Canadian patent applications have languished since 2000, even as they have boomed in the United States, many countries in Europe and China (CIC, 2011). In terms of patent quality (adjusting by the number of citations by subsequent patent applications), Canada does much better (OECD, 2011d), though, as in many other countries, patent quality seems to have declined over the past decade, even if measurement is difficult. This widespread decline in patent quality reflects in part the exhaustion of earlier technological possibilities (notably in pharmaceutical research), and partly the rise of patent proliferation as a new form of competition.

Small firms are especially vulnerable to litigation risk once they attempt to market their IP, as larger incumbents with the means to do so may subject entrants to the immense cost of defending themselves against (sometimes frivolous) claims. Canadian start-ups have had some bad experiences in this regard when attempting to enter the US market (where the onus of proof is on defendants, and juries in some US states overwhelmingly favour US claimants). The OECD recommends making intellectual property rights (IPR) systems in member countries more "SME-friendly" by diffusing knowledge and know-how about IPR, streamlining procedures and reducing application time, adequately structuring fees and costs, and improving litigation and enforcement mechanisms (OECD, 2011g). The OECD is also increasingly emphasising cross-licensing arrangements, open innovation and other forms of co-operation and collaboration as alternatives to litigation as a method of enforcing patent rights and diffusing knowledge (OECD, 2011d). These alternative methods rely much more on recognition of mutual benefits of knowledge sharing. They may be accelerated by the sheer technological difficulty of unravelling bundles of IP in areas like biotechnology. Canada's high level of social trust would seem to make it well suited for leadership in promoting such tendencies.

Copyright protection faces new challenges in the Internet age, where copying of music files, films, etc. is extremely cheap. Also, because network effects are integral to the business (and social) value of Internet services, exclusive rights to software and artistic output could inhibit this development if not carefully designed. The 2011 *Copyright Modernization Act* introduced new tools and exceptions to invest in IP and roll out cutting-edge business models in the digital era. Overzealous privacy protections could still have harmful effects, however, *e.g.* by blocking lucrative new sources of marketing to Internet advertisers, or by inhibiting the development of electronic medical records able to save lives through highly beneficial network effects. Policymakers must therefore weigh these real economic and social costs against the social benefit of privacy protection (Goldfarb and Tucker, 2011).

Technology transfer

The inability to capitalise on Canada's strong record in academic research leaves much potentially useful knowledge unexploited. The transfer of direct knowledge from academe to industry has always been the purview of the federal research granting councils (NSERC, SSHRC, CIHR for natural, social and health sciences, respectively). They fund placement programmes and research scholarships for university undergraduate, graduate and doctoral students who can then take their breakthrough research to industry and hope for commercial success, or at the very least gain a better understanding of how Canadian businesses operate. Internships, co-ops, and placement programmes have always been geared toward graduate-level students and newly minted university graduates; therefore, industry has had only that finite talent pool from which to choose when accessing placement programmes, leaving substantial resources in colleges untapped.

Investments in university research and technology transfer personnel have increased sharply since the early 2000s, while innovation output (as measured by patents and licenses for academic research) has risen far less dramatically. This suggests a low and declining productivity of technology transfer, especially in comparison with the United States where technology transfer surged over the same decade. Agrawal (2008) examines this "Canadian commercialisation discount" and attributes it chiefly to a weak commercialisation culture at universities, along with an overly bureaucratic mindset among technology transfer offices (TTOs) when it comes to deal making. The dearth of large high-tech firms acting as local demanders of innovation also plays a role, as may the lack of faculty superstars comparable to those found in the big US universities.

Policies have attempted to improve technology transfer in various ways. Public research is becoming more focused on issues of social relevance rather than purely curiosity-driven subjects. The marginal research dollar is increasingly tied to the needs of business. For example, academic grants may require signalling of their commercial relevance via co-funding by business. Community colleges are becoming proactive in directly meeting the needs of small business in areas of problem solving, process innovation and technical skills, even though they benefit from little taxpayer support via the granting councils. Students involved in such collaborations, *e.g.* via internships, view them as highly motivational learning experiences. Governments are also attempting to stimulate academic-business collaborations and knowledge transfers through networks of excellence, incubators and the like. While these methods may reduce informational asymmetries and transactions costs that stymie collaboration, and they have seen some marked successes in Canada, international experience shows that it is very difficult to create vibrant clusters of innovative activity, unless many conditions and incentives are present (Box 1.3).

Basic and applied research are essential parts of the innovation ecosystem and, as the private sector does not typically do much of either, the government has a special and irreplaceable role in funding them (MacIntosh, 2012). For example, three-quarters of the most important therapeutic drugs introduced world-wide between 1965 and 1992 had

Box 1.3. **Geographical clusters**

It is a well known fact that intensive innovative activity is more likely to take place within geographical clusters that are able to reap agglomeration economies – supply chain linkages, large labour pools and tacit knowledge diffusion – as epitomised by California's Silicon Valley, Singapore and Tel Aviv. Some research suggests that agglomeration effects are very limited in scope, not extending outwards by more than perhaps 10 km beyond a central zone (Baldwin *et al.*, 2008), so physical proximity is important for effective collaboration, despite all the advantages of modern communications. Investors in high-risk start-ups also like to be near their investments in order to monitor them. Innovation "hot spots" are few and far between (OECD, 2011e). They tend to arise somewhat spontaneously, often relying on a confluence of favourable factors such as a strong research university, or a public or corporate laboratory at its core, as well as urbanised social and artistic amenities and cultural diversity.

Government spending often plays a role as well, especially in promoting university hubs. For example, US military contracts with Stanford University helped to spur the development of Silicon Valley, as commercial ventures were spun off from the new silicon chip technology being developed for military purposes (Lerner, 2009). Famous firms like Intel got their start under the highly regarded US federal Small Business Innovation Research (SBIR) programme. Venture capitalists clustered in the region, setting up a virtuous cycle of funding and creativity. However, government support is not a sufficient condition. The darker side of the story is that governments everywhere have wasted large amounts of public money in attempting to artificially build the next great innovation cluster (Lerner, 2009). They should probably stay away from trying to do so and focus rather on creating the right framework conditions for innovation.

Canada has some notable hot spots in Montreal (aeronautics, operations research, video games), Waterloo (smart phones, ICT), and Toronto (life sciences), each based on very different approaches and models. Montreal has been significantly led by provincial government and universities, whereas Waterloo was more grass roots and business-oriented, reflecting perhaps the cultural heritage of the large German immigrant population that settled there (CCA, 2009).Toronto's MaRS Discovery District has benefited from strong public and private foundation support for hospital-based research and a number of excellent universities in close proximity within a diverse urban culture. There is a risk that some of these hotspots remain too close to academia and fail to develop their commercial dimensions.

their origins in public research; almost all drugs coming out of biotechnology companies had their origin at universities (Stephan, 2012). Pushing universities to become more business relevant in all areas risks a focus on short-term research with immediate applications and reducing projects that may have important long-term impacts on productivity and social welfare. Nevertheless, a marginal rebalancing away from basic research, as is currently being sought, is appropriate. To bolster this process, academics should face stronger incentives to produce commercially relevant and creative research. Review panels for competitive awarding of federal research grants should include experienced business people. They should make selections on the basis of researchers' track records, rather than just research proposals, as the latter may be very time consuming and could even stifle creativity (see Wheeldon and Gordon, 2011 for a critical view).

University TTOs have not been very efficient in their role – *i.e.* all too often holding out for top dollar in licensing fees or "hoarding" IP. Private markets of this sort may require a level of sophistication about IP and doing business that TTOs often lack. Universities need to overhaul TTOs to focus less on licensing fees and more on industry collaboration, infrastructure sharing and training (CIC, 2011). Provincial governments, which govern education, should send a clear signal to the universities to this effect.

The Competition Policy Review Panel suggested that Canada's tertiary education institutions could expedite the transfer of IP rights by moving to an "innovator ownership" model, learning the lessons of the University of Waterloo's extraordinary success in commercialising its faculty research (CPRP, 2008). The Expert Panel on the Commercialization of University Research proposed a federal IP framework modelled on the 1980 US Bayh-Dole Act, which facilitated the interest of business in commercialising university inventions by strengthening private property rights to federally funded research, while imposing uniform patenting and licensing procedures across universities (Advisory Council on Science and Technology, 1999). Agrawal (2008), though, finds that the current mixed-model system in Canada mimics the property rights effects of the US legislation well enough, and that the causes of inefficient technology transfer lie elsewhere, much of it outside the purview of federal policy, as argued above.

Conclusions

Canada clearly has the potential to be a nation of innovators and seems to possess all the right fundamentals to be a major international player in IP. What seems to be holding it back is a certain dichotomy in policies: at the general level, they internalise virtually all of the OECD market-based best practices, yet selective government supports to sectors, firm sizes and ownership structures may have serious impacts on incentives to innovate, succeed and grow. Estimating the economic/social costs and benefits of these selective policies will be needed to overcome the political hurdles to eliminating the least efficient of them. By levelling the playing field and letting market forces run their full course, business innovation in Canada can be unleashed and high productivity growth achieved. Governments should also resist going too far toward discretionary R&D policies, just as other OECD countries are moving toward the Canadian model of heavier reliance on tax credits in their search for efficiency. The education system should supply more skills and knowledge serving business innovation needs. A list of recommendations to strengthen the policy framework for innovation, drawing on the above discussion, is provided in Box 1.4.

Box 1.4. Recommendations for boosting business innovation

Provide a stronger culture of competition, risk taking and customer orientation

- Increase competitive intensity in network sectors and professional services, in line with *Going for Growth* (OECD, 2012a) and *Compete to Win* (CPRP, 2008) recommendations. Fully implement the Agreement on Internal Trade to dismantle provincial barriers. Clarify the net benefit test for FDI and apply it narrowly.
- Promote efficient and deep financial markets by: improved accounting for intellectual assets, more vigorous competition in financial services, and consistent and high standards in provincial securities market regulation.
- Examine how institutions can better develop cognitive and social skills for entrepreneurship and risk-taking. Support and encourage risk-takers across the board, from high-tech *avant-garde* to skilled trades.

Better target fiscal supports to R&D

- Scale down SR&ED tax subsidies, reducing the small firm subsidy rate toward that of large firms while keeping the base broad (inclusive of capital) to avoid distortions in technology choice. Restore the 20% general SR&ED rate.
- Streamline fragmented federal granting programmes to boost business interest in collaborations with academics. As IRAP is expanded, consider partial cost recovery of pre-commercial business advice.
- Carefully design support to venture capital by means of strictly temporary co-financing arrangements, giving private partners full management control and possibly capping government returns in order to leverage private returns. Eliminate tax credits to retail investors in LSVCC funds. Provide institutional support to angel funds.
- Co-operate with provinces to align their grants and tax credits to R&D and VC with federal government.
- Design low-budget-cost policies to foster market demand for innovations, including "green" technologies, *e.g.* consumer policies and getting prices right via carbon taxes. Public procurement is relevant here, though it needs to be carefully designed to focus on technology neutrality and performance to stimulate innovation.
- As the policy mix shifts toward more granting and procurement, design safeguards against the risks of: lack of capacity in the public sector to wisely choose projects; inefficient policies and market distortions (including at the international level) due to Canada-only provisions; and capture by vested interests.

Update institutional foundations of the "knowledge economy"

- Motivate technology transfer from academia by means of improved incentives for academics, *e.g.* by adopting a more open and inclusive research-granting process, and business vouchers for academic collaborations. Consider rationalisation of currently widespread distribution of research resources in order to promote Canadian "star" universities better able to command market interest for their research.
- Strengthen the IP system: *i)* modernise the relevant legislation/public agencies to enhance transparency and guidance to inventors; *ii)* establish national protocols for sharing/transfer of IP in academic-business collaborations; *iii)* provide IP management services to SMEs, *e.g.* within regional centres of excellence; *iv)* establish a specialised Patent Court or section of a court; and *v)* promote international IP collaboration.
- Build capacity to undertake comparative evaluations of fiscal supports to better guide funding allocations and programme design. This could be done by an arms-length Innovation Council as recommended by the Jenkins panel.
- Tailor privacy protections to minimise tradeoffs with knowledge diffusion and network benefits from the Internet and integrated electronic medical records.

Notes

1. There have been numerous cases, *e.g.* canola oil, in which Canada developed the technology but failed to commercialise it, ending up having to pay large royalties on foreign patents (CIC, 2011).
2. Nevertheless, there is a strand of research that concludes that policies that make business entry harder, such as strict bankruptcy laws or higher taxes on success, may lead to increased lending and higher-quality entrepreneurship. In US states with generous bankruptcy laws, for example, it is more difficult for low-income households to obtain loans (Gropp *et al.*, 1997).
3. A recent OECD study of eastern Germany showed that teaching can have a greater effect if linked to support for enterprise start-ups by students and staff, including mentoring, grants and incubation facilities (OECD, 2010a). This is starting to happen in Canada, where colleges are at the forefront of developing such support systems.
4. Small CCPCs are defined as having up to CAD 500 000 in prior-year taxable income and up to CAD 10 million in prior year taxable capital. As these thresholds are exceeded, the qualifying R&D expenditure limit for the 35% rate is phased out. At CAD 800 000 in income or CAD 50 million in capital, the firm is considered large and fully subject to the 20% general subsidy rate. Tax credits earned at the 35% rate are fully refundable for current expenditures and for 40% of capital expenditures. Those earned at the 20% rate are non-refundable, with the exception of qualifying expenditures of small CCPCs in excess of the CAD 3 million limit, which are eligible for 40% refundability (see Parsons, 2011).
5. Australia, for example, introduced in 2001 a premium R&D tax concession (over and above the baseline tax concession) for incremental R&D above a firm's most recent three-year average R&D expenditures, which is thought to have resulted in an acceleration of business R&D in that country (Cumming, 2007). However, in 2010 it replaced the hybrid volume and incremental-based schemes with a simpler and more generous volume-based scheme (OECD, 2010e). The R&D tax concession was replaced in 2011 by an R&D tax incentive scheme based on a tax credit (Australian Government, 2011).
6. The parameters used for the calculations are based on surveys of the empirical literature for Canada. The spill-over rates for SR&ED are assumed equal for large and small firms (56% on average, 110% for basic/applied research and 42% for experimental development), despite some evidence that they may be larger for large firms. Elasticities of response to R&D credits are also assumed equal across firm sizes. The spill-over benefit is assumed to be higher for IRAP-financed projects due to its use of targeting. See Lester (2012).
7. The report also makes reference to the German Fraunhofer institutes as particularly effective institutions for business finance and support. The Fraunhofer Gesellschaft operates a network of 60 institutes as an integral part of the technological virtuosity of German industry and competitive strength of its economy. It is funded one-third by government subsidies, one third by industry, and one-third by competitive public research grants. The institutes are customer-oriented, applied research organisations striving to transform scientific findings into useful innovations. They provide: *i)* highly specialised, professional R&D services to industry; *ii)* demand-driven research combined with scientific excellence; *iii)* strong integration with academia; and *iv)* autonomy combined with simple corporate rules and a strong brand (IPFSRD, 2011).

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