The Way Ahead

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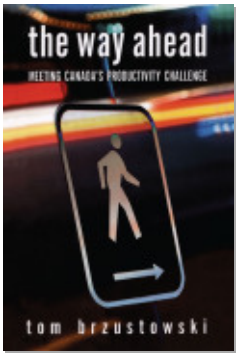

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CHAPTER 1

Canada in the World

In some ways a giant...

What are Canada's economic prospects in the world of the twenty-first century? To answer this question, this chapter presents a comparison between Canada and the other twenty-two most important economies, using a selection of readily available data. These data were chosen for their relevance to the issues that will shape the country's future. The chapter then moves on to examine a recent correlation of prosperity with excellence in science and engineering that is relevant to the knowledge-based global economy in which Canada's prospects must be realized.

How Canada compares with the top economies

Canada is the second-largest country in the world, larger than the United States or China by an area about the size of Germany. Only Russia is larger.

Among the 23 top industrialized countries, Canada is the fifth most prosperous, and has the 13th largest population and the 11th largest economy.[1] Table 1.1 lists four important characteristics for 23 of the world's most industrialized nations. Three are economic: the gross domestic product (GDP) in so-called purchasing power parity[2] (PPP) dollars for the year 2005,[3]

the population in the same year, and the GDP per capita for 2005. That last quantity will be referred to as "prosperity."[4] The fourth key characteristic is geographic: the area of the country, included to give some indication of its size. The table also includes the average (GDP per capita) for the world, a far less accurate number than those for the group of 23. Nevertheless, this rough value serves to show that Canadian prosperity is about three and a half times the world average.

The numbers in Table 1.1 clearly show that the traditional "ten times larger" ratio of the US to Canada is only a rough approximation. The US population is 9.0 times larger, and the US economy is 11.5 times larger. The fact that the ratio of economies is larger than the ratio of populations is another indicator of the productivity gap that we need to close.

Table 1.2 shows how Canada ranks among the 23 in a number of selected dimensions. The full set of data from which these comparisons were extracted can be found in the appendix.

Canada's population density is the second lowest in the group, 33 times smaller than the median value, and 200 times smaller than Taiwan's. Only Australia's is less. But that is really only part of the story. The recent census[5] has shown that 80% of Canadians live in cities. That means that over most of our land the population density is even lower, by a factor near five.[6] Such a low population density over a vast area has very significant implications for the communications and transportation infrastructure required to sustain small remote communities. The high cost of that infrastructure is part of the "operating cost" of Canada.

TABLE 1.1 A gross comparison of 23 industrialized nations

	GDP (2005 PPP) $ trillion	pop. (2005)	area, sq.km.	GDP/cap (2005 PPP) $
US	12.37	295,734,000	9,631,418	41,800
China	8.158	1,306,314,000	9,596,960	6,200
Japan	3.867	127,417,000	377,835	30,400
India	3.678	1,080,264,000	3,287,590	3,400
Germany	2.446	82,431,000	357,021	29,700
UK	1.867	60,441,000	244,820	30,900
France	1.816	60,656,000	547,030	29,900
Italy	1.645	58,103,000	301,230	28,300
Brazil	1.58	186,113,000	8,511,965	8,500
Russia	1.535	143,420,000	17,075,200	10,700
Canada	1.077	32,805,000	9,984,670	32,800
Mexico	1.066	106,203,000	1,972,550	10,000
Spain	1.014	40,341,000	504,782	25,100
S. Korea	0.9833	48,423,000	98,480	20,300
Australia	0.6427	20,090,000	7,686,850	32,000
Taiwan	0.6108	22,894,000	35,980	26,700
Netherlands	0.500	16,407,000	41,526	30,500
Sweden	0.2665	9,002,000	449,964	29,600
Switzerland	0.2621	7,489,000	41,290	35,000
Norway	0.1947	4,593,000	324,220	42,400
Finland	0.1584	5,223,000	338,145	30,300
Israel	0.1392	6,277,000	20,770	22,200
Ireland	0.1369	4,016,000	70,280	34,100
WORLD				**9,300**

TABLE 1.2 How Canada ranks according to some important parameters

measure	3 highest		median value	3 lowest		Canada
Population density, persons/sq.km.	Taiwan South Korea Netherlands	636 492 395	111	Australia Canada Russia	2.61 3.29 8.40	3.29
Median age	Japan Germany Italy	42.64 42.16 41.77	38.17	India Mexico Brazil	24.66 24.93 27.81	38.54
Ratio of the labour force to population	China Canada Germany	0.606 0.529 0.526	0.500	Mexico Israel Italy	0.352 0.386 0.421	0.529
Arable land loading, pers./sq.km.	Taiwan South Korea Japan	2960 2870 2790	520	Australia Canada Russia	40 73 115	73
Industry share of GDP, %	China Ireland South Korea	53.1 46.0 41.4	28.7	Brazil US France	14.0 20.7 21.4	29.1
Services share of GDP, %	US France Japan and Netherlands	78.3 76.1 73.5	67.9	China Ireland India	32.5 49.0 51.4	68.7
Annual electricity consumption per capita, kWh/cap.yr.	Canada Finland Sweden	15880 15110 14641	6264	India China Mexico	480.0 1661 1826	15880
Per capita daily oil consumption, bbl/cap.day	US Canada Netherlands Norway	0.0677 0.0668 0.0561 0.0560	0.0384	India China Brazil	0.0021 0.0049 0.0113	0.0668
Telephone land lines per capita, no./cap.	Sweden Norway Switzerland	0.731 0.727 0.724	0.538	India Mexico China	0.045 0.150 0.201	0.608
Land lines plus mobiles per capita, no./cap.	Taiwan Norway Sweden	1.679 1.633 1.614	1.335	India China Mexico	0.069 0.407 0.415	1.011

Canada is in the mainstream of the "23" by most measures, except for four of those shown in Table 1.2. Canada is at the high end in the ratio of labour force to population, and in the consumption of electrical energy and oil. It is at the low end in population density and population per unit area of arable land.

Table 1.2 does not compare coastlines, but Canada has by far the longest coastline in the world, more than five times longer than Russia's and almost seven times longer than Japan's. On paper, that makes us potentially the leading maritime nation, with huge benefits from off-shore resources and ocean access to the world. In practice, much of our coastline is in the north and the far north, where the challenges are as enormous as the assets.

The median age of Canada's population is only slightly greater than the median age for the 23, and its age structure is not very different from the median structure. But our population is significantly older than those of our NAFTA partners. Mexicans have a median age of 24.93, and Americans 36.27, compared with Canadians' 38.54. In Canada, 17.9% of the population is younger than 14. In the US and Mexico, those numbers are 20.6 and 31.1%, respectively. And at the other end of the scale, 13.2% of Canadians are 65 or older, compared with 12.4% of Americans and only 5.6% of Mexicans. Demographics have major implications for the economy, and we will be revisiting them in a later chapter.

The number of people per square kilometre of arable land—call it arable land loading—is a measure of the ability of a country's agriculture to feed its people. Low values identify the bread baskets of the world, high values the food importers. Canada is a bread basket.

The composition of the GDP reflects the maturity of the economy. Table 1.2 shows that the younger economies depend much more on industry than on services; the opposite is true in

the older ones. At first sight, Brazil seems to be an anomaly, but its situation becomes clearer when agriculture (extraordinarily high at 20%) and industry are considered together, leaving 66% of GDP dependent on services. This number is below the median for the group.

The three highest per capita consumers of electric power are Canada, Finland and Sweden, all of them cold northern countries with a long dark winter. Canada and the US are in a league of their own in consuming oil, probably because of a heavy reliance on the automobile for commuting and on trucks for moving goods over long distances. In third place, at about 20% lower per capita consumption, are Norway and the Netherlands. This ranking of the Netherlands is a surprise, given the popular image of thousands of Dutch people commuting by bicycle.

The last two rows of Table 1.2 deal with telecommunications, a subject of great importance to Canada because of the very low population density. Canada has more than the median number of telephone land lines per capita but significantly fewer mobile phones. While we obviously have responded to the great need for keeping in touch over long distances, other countries have been quicker to adopt cell phones for remaining connected in densely populated areas.

Excellence in science and engineering

One important determinant of a nation's success in the global knowledge-based economy of the twenty-first century was not included in Table 1.2. Excellence in science and engineering deserves a section of its own.

Science has been a global enterprise for centuries. Scholars around the world openly communicate the results of their basic

research, and international peer review is the established instrument of quality control. Senior researchers meet at international conferences and workshops, visit each other's labs, and sit on each other's advisory committees. Postdoctoral fellows move among the world's leading research centres to expand their experience, and it is not rare for graduate students to spend time in research laboratories abroad to learn specific techniques or attend specialist summer schools and like institutions. The best scientific journals are international in the make-up of their editorial boards and the affiliations of the authors who publish in them, and the best textbooks are translated into many languages and used around the world.

In the twentieth century, and particularly after World War II, Canadian engineering research developed in the same pattern, but its internationalization was even faster, enhanced by globalization of industry. Today, the biggest companies are multinational. Supply chains are international, and most high- and medium-technology products contain components made in many countries. In addition, foreign direct investment (FDI) moves both capital and knowledge around the world.

In the last decade, the quality of Canadian science and engineering has taken a leap forward. Sustained new investments, led by the federal government and supported by the provinces, have helped university researchers attain excellence in many important fields. But that excellence is not confined to the universities. It becomes diffused across the economy, largely through students who are taught by active university researchers, and then take jobs in industry and in government laboratories. It is also spread through university-industry research partnerships that involve the companies that are active in R&D and through consulting by individual professors. There will be more to say

about this diffusion later, but for now it is sufficient to note that excellence in university science and engineering promotes excellence in science and engineering across the economy. And that has an impact on wealth creation and national prosperity.

A useful indicator of a nation's excellence in science and engineering was proposed by the UK Science Advisor, David King.[8] King counted the number of research papers published by researchers during a specific four-year period, and took its fraction of the total as a measure of each nation's activity in science and engineering. He then applied a demanding quality criterion, counting only those papers that were among the 1% most often cited by other researchers. The fraction of that top 1% contributed by a nation was taken to be the indicator of that nation's excellence in science and engineering. One further step seems reasonable, however. Normalizing the excellence indicator by dividing it by the nation's population makes it a better indicator of the intensity of top-tier activity.

Canada has about ½ of the world's population, produces about 2% of the world's GDP,[9] and publishes more than 4% of the research papers in science and technology. Where does that put us in the group of 23 top economies?

The answer is shown in Figure 1.1, where the ratio of the nation's GDP per capita to the world average is plotted against the indicator of excellence in science and engineering described above. The nations are the same ones as in Table 1.1, except for Mexico and Norway. The prosperity data are for 2005. The four-year period for counting published papers is 1997–2001, which gives a reasonable time lag for the diffusion of new knowledge.

The correlation is very strong because globalization means that there is just one international system of science, engineering, technology, and industry. That system rewards excellence, and

it particularly rewards growing excellence on the part of those who started far behind. This is shown in the case of the four BRIC nations—Brazil, Russia, India, and China—that have recently been moving up the value chains of established industries. The actual location of each country on this plot is the result of its economic history; the data are what they are. This is very different from the scatter of measurements in a physical experiment.

One way of interpreting this figure is to say that some countries (such as the US, Japan, Taiwan, and Ireland) are better than average at connecting their excellence in science and engineering with wealth creation. And for whatever reasons, others (such as Israel, Sweden, the UK, and the Netherlands) are not as good as most of the rest of the group.[10] The figure also implies some policy directions. Given its upward slope to the right, a nation must always try to climb the curve by improving the science and engineering excellence indicator, and that means competing on the quality of research. The public sector has the major role in that. However, at the same time, nations must try to improve their capacity for connecting excellent research with wealth creation, and they must strive to move up from the group curve as steeply as possible. That is commercialization, and it is the role of the private sector. Successful innovations in commercialization in one country will be copied by the others,[11] but even so, nobody can afford to stop trying to break ahead of the pack. The public attention paid to innovation and commercialization policies in the 23 economies is a clear sign that governments understand this very well.

Indeed, just this point is made very clearly in the science and technology strategy recently released by the Government of Canada: "Now that we have built a strong research foundation, we must strive for excellence in Canadian science and technology,"

and "[t]he private sector in Canada needs to do more of what it alone can do, which is to turn knowledge into the products, services, and production technologies that will improve our wealth, wellness, and well-being."[12]

The whole process is like climbing the down escalator. If you slow down, you fall behind.

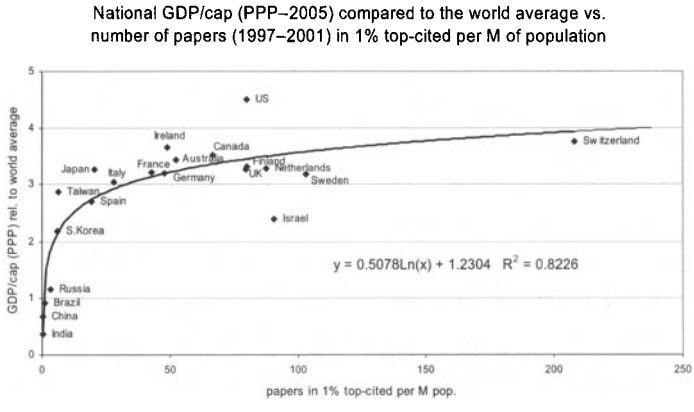

FIGURE 1.1 Prosperity and excellence in science and engineering

But in the competition to establish excellence, there is a cloud on the Canadian horizon. Not enough Canadians earn advanced degrees.

Figure 1.2 shows how Canada and the US have compared in the numbers of degrees granted in all fields from 1993 to 2003 by two university systems that are similar. Comparing degrees granted in all fields removes any ambiguity about the labelling of programs.

The data show that the ratio of Bachelor's degrees followed the ratio of populations closely until the mid-90s, when a gap developed. The situation is more serious at the doctoral level.

There the numbers of Canadian degrees granted lagged behind the US numbers by about 20% over the whole period. One could argue that the US numbers are inflated by the very high proportion of foreign students in US doctoral programs, but that point is moot since many of these foreign students stay in the US and contribute to the nation's competence, which is the real issue in making the comparison.

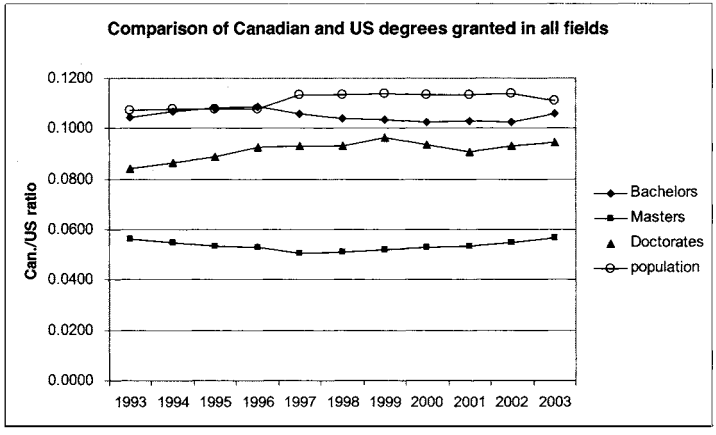

FIGURE 1.2 A comparison of the numbers of degrees granted by Canadian and US universities in all fields

The situation is much clearer at the Master's level. There the Canadian numbers run at about half of the US levels. This situation is particularly serious for two reasons: first, the Master's degree is commonly used for professional upgrading by engineers and other professionals employed in industry. And second, the MBA degree provides the most common route by which scientists and engineers are prepared for management. Canada's lagging performance in this area is a serious situation that must be remedied, as has already been pointed out by others.[13]

The "small country" put-down

All too often we hear the statement, "Canada is a small country. We can't do that." On some measures, Canada is indeed a small country, as the tables above have shown. But in many things that matter, Canada is far from small. Our population exceeds that of many countries (Australia, Finland, Ireland, the Netherlands, Switzerland, Sweden, Taiwan, etc.) that are often held up as examples of success for Canada to learn from. Our huge land holds a rich endowment of natural resources. Our education system is very good and accessible, and we have achieved excellence in many areas of science and engineering. "Canada is a small country," is too easily used—most often by Canadians—as a put-down to squelch the ambitions of other Canadians who are more enterprising and daring. The danger is that Canadians might accept it as conventional wisdom.

Canada's prospects

All things considered, today Canada's prospects are very good. Our economic history brought us prosperity, largely through the sale of commodities: farm products, raw materials extracted from natural resources, and some manufactured products designed elsewhere. More recently, there have been spectacular successes by innovative Canadian companies in the high-tech industries and other sectors as well, but the number of these companies is small—far too small. One thing is clear: in spite of some extraordinary achievements, Canada's current prosperity has not generally been earned by excellence in science and engineering.

On the contrary, our prosperity has made it possible for Canadian science and engineering to achieve excellence. This is a very fortunate state of affairs at a time when commodity producers face

increasing competition from third-world countries with much lower labour costs, and when imbedded knowledge is becoming the main source of value-added in more and more products.

Canada has achieved excellence in science and engineering just as this is becoming the key to prosperity. The remaining chapters of this book describe what needs to be done to seize this opportunity to make Canada's prosperity both greater and sustainable.

We must refute once and for all the damning indictment that "Canada is a country that never misses an opportunity to miss an opportunity."[14]

NOTES:

1 There seem to be elements of history and courtesy in Canada's membership in the G-8, but we clearly belong to the "Trillion dollar" club.

2 PPP is the conversion of currencies on the basis of purchasing power rather than nominal exchange rates that may include political influences, or market exchange rates that fluctuate with time. PPP brings prices to a common level, so that one PPP dollar buys the same amount of an appropriately selected "basket" of goods and services in every country.

3 For emphasis, a gap has been left in the table between those countries whose GDP exceeds one trillion dollars and the rest.

4 This idea can be found in the opening words of Adam Smith's great book: "The annual labour of every nation is the fund which originally supplies it with all the necessaries and conveniences of life which it annually consumes, and which consist always either in the immediate produce of that labour,

or in what is purchased from other nations. According, therefore, as this produce, or what is purchased with it, bears a greater or smaller proportion to the numbers of those who are to consume it, the nation will be better or worse supplied with all the necessaries and conveniences for which it has occasion." Adam Smith, "Introduction and Plan of the Work," Chapter 1, page 1, An Inquiry into the Nature and Causes of the Wealth of Nations, New Edition, Adam and Charles Black, Edinburgh (1863).

5 Statistics Canada Reports on the 2006 Census, on their website.

6 The situation in Australia is probably not much different.

7 The data for Table 1.1 were taken from the CIA World Factbook accessed on the Internet in January 2006.

8 David A. King, "The scientific impact of nations," Nature, Vol. 430, 15 July 2004, pp. 311–316.

9 These two numbers suggest that Canada's GDP per capita is about four times the world average. Table 1.1 shows that it's closer to 3.5.

10 These differences can be understood better in the context of the economic history of the respective countries. A recent paper: T. A. Brzustowski, "National prosperity and excellence in science and engineering research," Optimum Online, Vol. 37, Issue 2, June 2007 does this in the form of five pairwise comparisons: Germany vs. Japan, Finland vs. Ireland, the UK vs. Italy, Switzerland vs. Israel, and US vs. Canada.

11 That doesn't necessarily mean that the whole curve will shift upward as a result, since the national prosperity is divided by the world average. So in fact, the curve could shift downward if the less developed economies grew faster

than the developed ones, and the world average (GDP per capita) grew faster than the average for the 23.

12 Government of Canada: "Mobilizing Science and Technology to Canada's Advantage," May 17, 2007, Summary, page 3.

13 "Rebalancing priorities for Canada's prosperity," Report on Canada 2006, p. 31, Institute for Competitiveness & Prosperity, March 2006, ISBN 0-9737377-4-3.

14 Michael Hammer in a speech in Toronto in the late 1980s.

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