Science-Metrix

Science & Technology in Poland

Prepared for the

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514.495.6505 · 4572 avenue de Lorimier · Montréal · Québec · Canada · H2H 2B5
info@science-metrix.com · www.science-metrix.com

1 Poland in the Post-Warsaw Pact Era

Poland appeared as a nation around the middle of the 10th century and experienced its golden age in the 16th century under the Jagiellonian dynasty. During the century that followed, the strengthening of the gentry and internal disorders weakened the nation so much that it was partitioned between Russia, Prussia, and Austria in 1772. Poland regained its independence in 1918, only to be overrun by Germany and the Soviet Union in World War II. It became a Soviet satellite country following the war, but one that was comparatively tolerant and progressive. Labour turmoil in 1980 led to the formation of the independent trade union "Solidarity", which over time became a political force and by 1990 swept the parliamentary elections. A "shock therapy" program during the early 1990s enabled the country to transform its economy into one of the most robust in Central Europe and to adopt a new constitution in 1997 (CIA. 2002. The World Factbook 2002).

The President, the supreme representative of the Republic of Poland, is elected in direct elections for a five-year term of office and can veto laws that can, however, be overriden by a qualified majority in of the Sejm. Poland applied for membership to the European Union in 1994 and is being considered for the forthcoming 2004 enlargement. Nevertheless, important hurdles have to be overcome before its acceptance to the EU. For instance, unemployment is currently at 17.5%, and there are fears that it will rise further. An editorial of the Financial Times argued that "[l]oss-making state-owned enterprises, red tape, official corruption and excessive taxes all hold Poland back. Without change, the country will be in no condition to compete in the EU".

Poland's population is about 20% larger than that of Canada, and its labour force counts for about 44% of the population, which is slightly less than in Canada (Table I). Canada's GDP per capita is about three times as large as that of Poland.

Table I Basic Socio-Economic Statistics

	Poland	Canada
Area (sq km)	312,685	9,976,140
Population (July 2002 est.)	38,625,478	31,902,268
Labour force (2001)	17,600,000 (44% of pop.)	16,400,000 (51%)
GDP*	U.S. $368 billion	U.S. $923 billion
GDP per capita*	U.S. $9,500	U.S. $29,400
Government type	Republic	Parliamentary democracy

* Purchasing power parity – 2002 est.
Source: CIA. 2002. The World Factbook 2002.

An important proportion of the Canadian population has Polish origins. In fact, with 193,000 Polish-born Canadians (3.9% of the migrant community), this community is the seventh largest migrant community in Canada. Relations between Canada and Poland are excellent with extensive high-level political contacts and increasing military co-operation and academic relations (DFAIT, 2003). Since 1990, more than 25 bilateral agreements have been signed. At least four major bilateral agreements (Culture, Academics and Sports Relations, Agriculture, Environmental Cooperation and Defence) will open the way to scientific and technological cooperation.

2 Science and Technology Inputs in Poland

Canada has a gross expenditure in R&D (GERD) that is close to seven times larger than that of Poland. In fact, the GERD as a percentage of the GDP is about three times larger (Table II). Poland has an extremely weak culture of intellectual property protection with only about 30 inventions protected at either the European or United States level. Not surprisingly, whereas 19% of Canada's manufactured exports consist of high-tech goods, this figure is only 3% in Poland. Canada has more than five times as many personal computers per 1,000 inhabitants and four times as many Internet users. However, Poland spends nearly as much on education as Canada does, although its population does not enrol in higher education as often as that of Canada.

Table II Basic Science and Technology Statistics

	Poland	Canada
GERD*	2,611	17,437
GERD as % of GDP*	0.7%	1.9%
Applications for patents to the EPO in 1998	27	1,329
Patents granted by the USPTO	29	3,759
High-Tech exports (% of manu. exports)	3%	19%
Personal computers (per 1,000 people)	85	460
Internet users (million)	3.8	13.5
Public expenditure on education as % of GDP**	5.0%	5.5%
Enrolment in Tertiary Education**	1,220,651	1,579,571

* Purchasing power parity – 2001 est.
** School year 1999/2000
Source: World Bank World Development Indicators; OECD Main Science and Technology Indicators.

Although Poland spends much less than Canada on R&D, its number of researchers per capita is in the same range. Canadian researchers however dispose of greater resources such as equipment and, as one can see in Table III, a larger support staff. Compared to Canada, Poland has a considerably larger share of R&D personnel who are in higher education and in government. However, its share of personnel in business is less than half the percentage of researchers in this sector in Canada. In absolute numbers, Canada has five times as many researchers in business, which goes a long way in explaining why Canada has a larger share of exports in manufactured goods that can be considered as high-tech products.

Table III R&D personnel by employment in FTE in 1999

	Poland			Canada		
	Researchers	Support	Total	Researchers	Support	Total
Higher education	35,284	7,664	42,948	33,250	10,910	44,160
	63%	30%	52%	37%	22%	31%
Government	10,811	8,274	19,085	7,420	9,070	16,490
	19%	32%	23%	8%	18%	12%
Business	10,327	9,987	20,314	49,500	28,030	77,530
	18%	39%	25%	55%	56%	55%
Private non-profit	11	10	21	640	1,620	2,260
	0%	0%	0%	1%	3%	2%
Total	56,433	25,935	82,368	90,810	49,630	140,440
	100%	100%	100%	100%	100%	100%
Researchers per M Pop.	1,462	672	2,134	2,353	1,286	3,638

Source: OECD Main Technology Indicators, 2002

The GERD in Poland is largely financed by government (65% versus 32% in Canada). Industry is not a large contributor (31% versus 42% in Canada). Furthermore, Poland has much fewer external sources of financing for the GERD than Canada has– only 2,4% versus 15,5%.

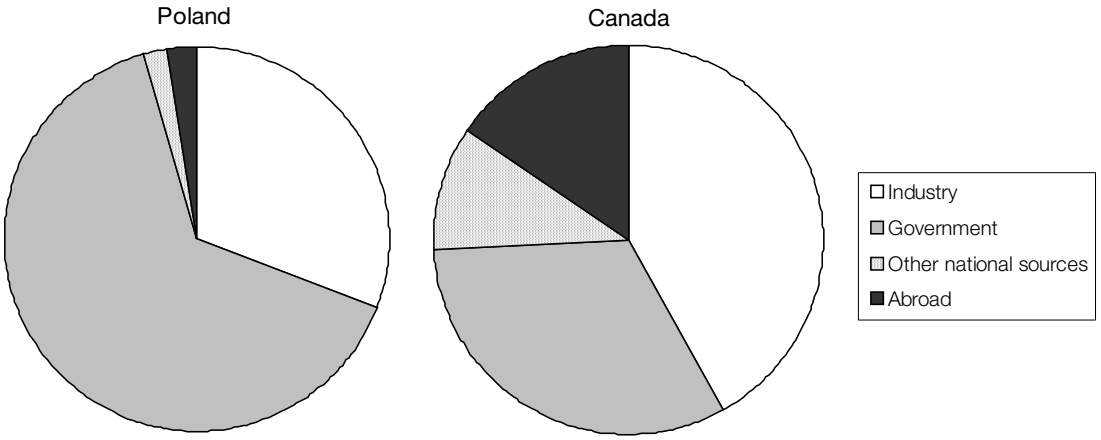

Figure 1 Percentage of GERD financed by sector in Poland and Canada, 2001
Source: OECD Main Technology Indicators, 2002.

3 Scientific Production in Poland

Figure 2 shows that the number of papers written by Polish researchers annually has grown steadily since 1990 – a 56% increase in 11 years. By contrast, the number of papers by Canada grew by only 13% during the same period. Figure 3 shows that although the level of collaboration between these countries is relatively small, its growth is faster than the growth of papers published by either country. In fact, between 1990 and 2000, the number of co-authored papers nearly doubled, going from 82 to 154.

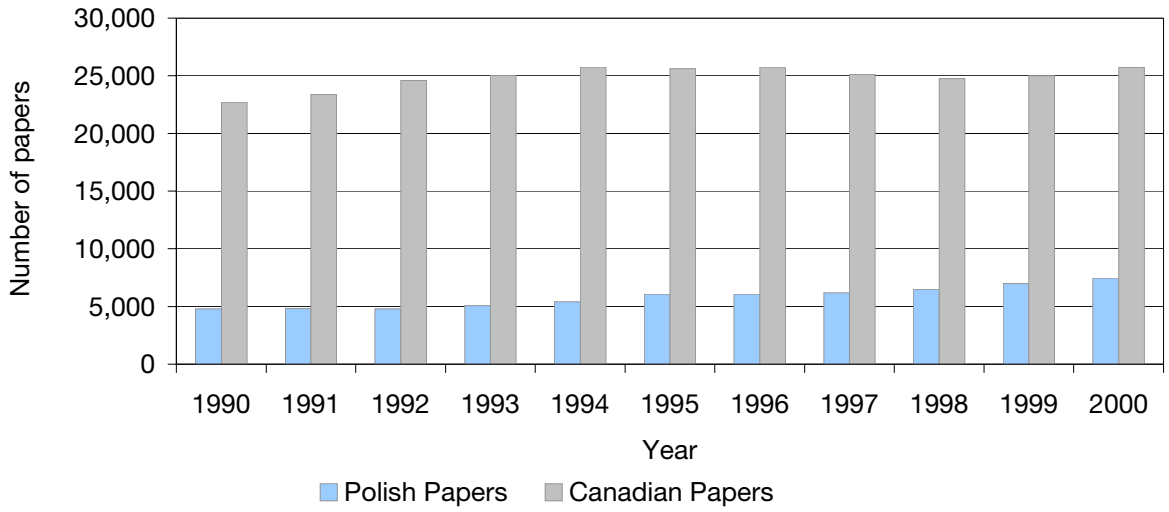

Figure 2 Scientific Papers by Poland and Canada, 1990-2000
Source: Science Citation Index, compiled by OST and Science-Metrix.

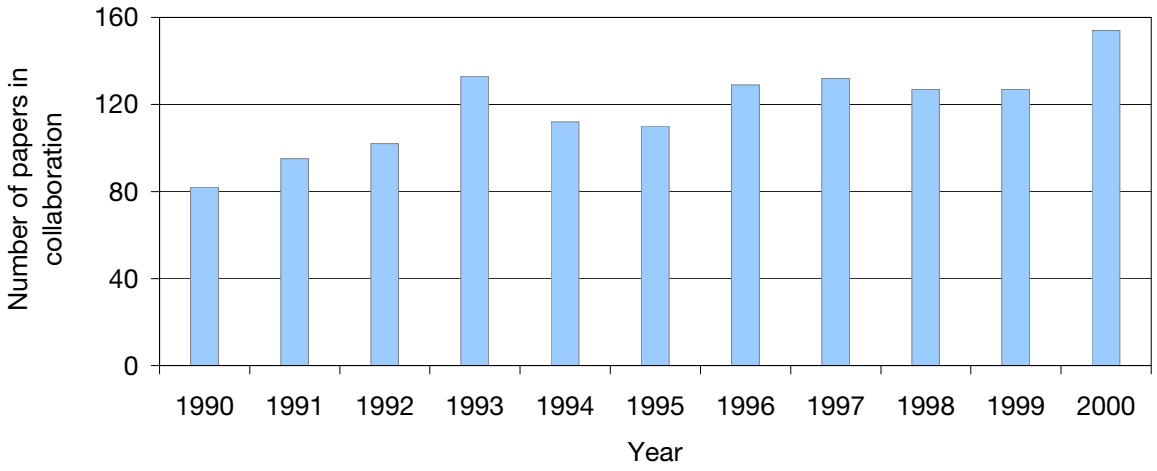

Figure 3 Scientific Papers in Collaboration by Poland and Canada, 1990-2000
Source: Science Citation Index, compiled by OST and Science-Metrix.

Table IV presents the leading institutions in Poland in terms of scientific output between 1997 and 2001. The leading institution in terms of quantity of papers is clearly the Polish academy of Science with 7,673 papers (22,5% of Polish scientific output). However, only three institutions publish papers in journal that are more frequently cited than the world average (relative weighed impact factor – RWIF>1) and all three are in the field of physics: the Nicolaus Copernicus Astronomical Center, the Andrzej Soltan Institute for Nuclear Studies, and the Henryk Niewodniczanski Institute of Nuclear Physics. The Warsaw University and the Jagiellonian University both combine a relatively strong impact factor and a large number of publications.

Table IV Leading Institutions in Natural Sciences and Engineering in Poland, 1997-2001

Institution	Nb Papers	RWIF
Polish Academy of Sciences	7,673	0.83
Warsaw University	3,352	0.96
Jagiellonian University (Kraków)	2,745	0.89
Wroclaw University	1,457	0.75
Adam Mickiewicz Univesity in Poznań	1,449	0.77
Warsaw University of Technology	1,192	0.78
Henryk Niewodniczanski Institute of Nuclear Physics	1,175	1.06
Wroclaw University of Technology	1,063	0.71
Marie Curie-Sklodowska University (Lublin)	954	0.74
Stanislaw Staszic University of Mining and Metallurgy (Kraków)	930	0.97
Silesian University (Opavě)	905	0.75
Łódź University of Technology	905	0.71
Nicholas Copernicus University (Torun)	831	0.84
University of Łódź	795	0.59
Andrzej Soltan Institute for Nuclear Studies (Świerk/Otwock)	783	1.09
University of Gdańsk	764	0.83
Gdańsk University of Technology	655	0.83
Poznań University of Technology	546	0.73
Medical University of Łódź	446	0.62
Medical University of Warsaw	440	0.72
Medical Academy in Gdańsk	398	0.70
Institute of Electronic Materials Technology (Warsaw)	393	0.71
Silesian University of Technology (Gliwice)	370	0.72
Technical University of Szczecin	345	0.65
Nicolaus Copernicus Astronomical Center (Warsaw)	287	1.18

Source: Science Citation Index, compiled by OST and Science-Metrix.

Table V shows that Poland has 3.6 times less papers indexed in the Science Citation Index than Canada has. Globally, 2% of the papers by Poland are written in collaboration with Canada, whereas 0.5% of Canadian papers are co-authored with Polish researchers. Poland specializes in physics and chemistry and has nearly as many papers as Canada in those fields. Physics is clearly the field where the greatest number of collaboration is observed, since 40% of co-authored papers are in this field. This means that a sizeable portion of Polish-Canadian collaboration is not bilateral but rather part of large-scale international projects in physics.

Mathematics is one field in which both countries are specialized and where collaboration is relatively frequent. Poland has an important percentage of papers in earth and space that are written in collaboration with Canada. In engineering, the two countries are already collaborating extensively and the countries' indices of specialization in this field are similar. Collaboration in the life sciences, an area where Canada is traditionally strong, is of little importance.

Table V Scientific output, specialization index and collaboration between Poland and Canada by field, 1997-2001

	Poland				Canada		
	Papers	S.I.	% Collabo.	Collabo.	Papers	S.I.	% Collabo.
Biology	1,643	0.64	1.6%	26	14,152	1.53	0.2%
Biomedical Research	3,034	0.56	1.8%	56	21,664	1.10	0.3%
Chemistry	8,526	1.91	0.9%	80	10,996	0.68	0.7%
Clinical Medicine	4,314	0.40	1.9%	80	40,425	1.04	0.2%
Earth and Space	1,546	0.81	2.8%	43	10,930	1.58	0.4%
Engineering	2,905	0.96	2.8%	82	10,789	0.98	0.8%
Mathematics	1,096	1.49	2.8%	31	2,850	1.07	1.1%
Physics	10,966	2.15	2.5%	269	11,314	0.61	2.4%
Unknown	44	0.40	2.3%	1	494	1.23	0.2%
Total	34,074	1.00	2.0%	668	123,614	1.00	0.5%

Source: Science Citation Index, compiled by OST and Science-Metrix.

Table VI shows that Warsaw University and the Jagiellonian University are Canada's greatest collaborators. In turn, the University of Toronto and McGill University are Poland's two largest collaborators. This means that the best Polish and Canadian universities are the greatest collaborators and that both countries certainly benefit from one another. However, one must be careful in the interpretation of these data, since two collaborative projects in physics are responsible for the patterns one can observe in Polish-Canadian collaboration. For instance, the universities appearing in the top left part of the table are all (except for the Polish Academy of Sciences) involved in the Zeus project, a collaboration of about 450 physicists, who are running a large particle detector at the electron-proton collider HERA at the DESY laboratory in Hamburg. The collaboration between the Stanislaw Staszic University of Mining and Metallurgy and

Canadian universities takes place within the OPAL experiment using the Large Electron-Positron collider and is therefore due to work carried out by a large team at CERN.

Table VI Inter-institutional collaboration between Poland and Canada in the natural sciences and engineering, 1997-2001

	University of Toronto	McGill University	York University	University of Alberta	TRIUMF	University of British Columbia	University of Victoria	Université de Montréal	Carleton University	National Research Council	University of Waterloo	McMaster University	University of Calgary	Université du Québec à Hull	TOTAL
Warsaw University	59	62	58	6	-	2	-	2	1	2	5	12	5	7	128
Jagiellonian University	62	55	57	1	10	-	-	1	-	3	-	-	4	-	102
Polish Academy of Sciences	2	6	3	14	-	1	-	6	2	9	3	5	2	-	94
Henryk Niewodniczanski Inst. of Nucl. Physics	51	48	49	-	16	9	10	-	-	3	1	1	-	-	76
Andrzej Soltan Institute for Nuclear Studies	55	54	54	-	-	-	-	-	-	1	-	1	-	-	60
University of Mining and Metallurgy in Kraków	54	53	54	1	1	1	1	1	1	-	-	1	-	-	57
Stanislaw Staszic University of Min. and Met.	-	4	-	41	43	42	42	42	42	-	-	1	-	-	50
Adam Mickiewicz Univesity in Poznań	-	-	-	3	-	1	11	-	-	-	1	2	6	-	35
Wroclaw University of Technology	1	-	-	-	-	-	-	-	-	10	4	-	-	13	34
Warsaw University of Technology	1	2	-	-	-	-	-	-	1	-	4	1	-	5	30
Nicholas Copernicus University	5	-	1	1	-	3	-	-	-	4	1	1	4	-	21
Medical University in Poznań	13	-	-	-	-	-	-	-	-	-	-	-	-	-	13
Łódź University of Technology	-	1	-	1	-	-	-	3	-	3	-	1	1	-	12
Nicolaus Copernicus Astronomical Center	5	-	-	-	-	-	-	1	-	-	-	-	5	-	11
TOTAL	105	83	66	72	61	65	64	60	47	41	33	26	28	25	668

Source: Science Citation Index, compiled by OST and Science-Metrix.

Academic relations between Polish and Canadian institutions are well developed in terms of faculty and university-level agreements and are strengthened by student and researcher exchanges. For example, between 1990 and 2000, the Jagiellonian University signed three agreements with the University of Guelph, University of Ottawa and Trent University. The Polish Academy of Sciences (PAS) cooperates with its vis-à-vis with more than 60 institutions in 40 countries. In particular, in 1996, the PAS signed a bilateral agreement with the Royal Society of Canada. Many faculty-level agreements have been concluded in the fields of management, economics, Polish and Canadian studies and engineering. Such agreements include those between the Academy of Management in Łódź and the University of Toronto, between the Warsaw School of Economics and the Université de Montréal and between the Białystok University of Technology and the Université du Québec à Trois-Rivières. These agreements are in addition to several multilateral agreements on cooperation in physics and nuclear science.

4 In brief

- Poland has been changing rapidly since the break of the Warsaw Pact. It is facing several challenges in science and technology, most particularly the need to develop the share of S&T performed and financed by industry. It needs to develop its portfolio of foreign patents and expand its exports in high-tech goods.
- Poland needs to attract external sources of financing to increase its level of R&D.
- Enrolment in higher education in Poland is high, which confirms the high value traditionally given to education in Central Europe.
- Poland's scientific output appears mostly in journals that are cited less often than average. Presumably, this is the result of the inheritance of a different scientific culture than in western countries, of a language barrier that Polish researchers have yet to overcome and of a lack of resources to be able to acquire the expensive equipment used in modern science.
- An important proportion of cooperation between Poland and Canada is made up of international research projects in physics. There are several bilateral agreements, but these have yet to make their mark in terms of co-authored papers.