

1

Canadians Studying Abroad and the Development of Statistics in Canada

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“Canada is the Scotland of America, and a proof is before you. Scotland gave a King to England in 1603; to-day Canada gives a President to the American Statistical Association.” (Coats, 1939)

1.1 Introduction

The American Statistical Association (ASA) was created in 1839, and for many years was one of the key professional associations for Canadian statisticians. For much of its early history and into the 1930s, the ASA and its *Journal* were dominated by a focus on economic and other forms of official statistics. Thus it was fitting that Robert H. Coats, the Dominion Statistician and an economist by training (BA 1896 Toronto), became the first Canadian president of the ASA in 1938. By the time of the creation of two statistical societies in Canada in the 1970s, later merged to form the Statistical Society of Canada (SSC), and a separate *Canadian Journal of Statistics*, academic statistics in Canada had come into its own. Bellhouse and Genest (1999) describe some of these activities. Nonetheless, the influence of the US on statistics in Canada has been deep and long-lasting. Well into the 1960s and beyond, many Canadian statisticians received their graduate training in the US and returned for the greater benefit of Canada, while others stayed in the US, enhancing Canada’s reputation for the quality of its exports. Here we examine how statistics grew as a discipline in Canada up to about 1970 through the training of statisticians and the external influence, mainly American, on

that growth. Those who returned developed or enhanced statistics groups and academic programs at Canadian universities.

To recognize the early “pioneers of statistics in Canada,” the SSC created the award of Honorary Member in 1980 and conferred it on five statisticians (Maag, 1980). The next year the Society conferred three more honorary memberships (Fellegi, 1983), again on statistical pioneers. Since the theme of the paper is statistical training, we note that of the eight honorary members in the early years of the award, four had substantial teaching careers at Canadian universities: Daniel DeLury at the University of Toronto, George Edgett at Queen’s University, Cyril Goulden at University of Manitoba, and Ernest Keeping at University of Alberta. Of these four, only DeLury received all his degrees in Canada (BA 1929; PhD 1936 Toronto). Edgett (BA 1923; MA 1926 Mount Allison) obtained his PhD from the University of Illinois in 1936 and Goulden (BSA 1921; MSA 1923 Saskatchewan) from Minnesota in 1925. Keeping initially studied in England (BSc 1916 London) and later studied with Harold Hotelling at the University of North Carolina. This trend began before these pioneers and continued for many years afterward.

In the published descriptions of the work of these early pioneers, some claims were made about their contributions to the development of courses in statistics at their universities: DeLury “developed widely-used lecture notes for statistics courses”; Edgett joined Queen’s in 1930 and taught “the first statistics course in a Mathematics Department in Canada” beginning in 1933; Keeping “developed an advanced level course in statistics, probably the first such course given in Canada” in the early 1930s. No mention was made of Goulden’s teaching career at University of Manitoba; see Bellhouse (1992) for a description. One might be tempted to conclude that these four were the first to develop statistics courses at Canadian universities, although Watts (1984) cites evidence of a few statistics courses offered in the 1910s, mainly in economics departments and business schools. We have found that statistics courses were developed in mathematics departments in Canada in the 1920s or before. Like the “statistical pioneers,” these early instructors of statistics were typically trained at the undergraduate level in Canada and at the graduate level in the US. We describe some of these developments.

1.2 Statistics’ Rise as a Modern Field in North America

During the Victorian era the field of statistics in both the UK and the US was defined by the collection and tabulation of data about social and economic issues. It is the mathematization of statistics that defines the field today. This occurred in late Victorian times initially with Francis Galton and Francis Y. Edgeworth (Stigler, 1986). In the 1890s, Karl Pearson developed a theory of mathematical statistics (Magnello, 2009). His work was motivated by

Charles Darwin's study of biological variation and evolution, and influenced by W. F. R. Weldon's data and scientific questions. Shortly thereafter Pearson established the Drapers' Biometric Laboratory at University College London in 1903, which in 1911 became the first department of statistics, although it only began to offer a degree in mathematical statistics in 1915. In 1901, with Weldon and Galton, Pearson also founded *Biometrika*, the first journal primarily devoted to the development of statistical methodology and theory. At the time the publications of the Royal Statistical Society (RSS) and the ASA were focused primarily on economic and vital statistics, and contained only limited amounts of methodology and essentially no theory until well into the twentieth century. The founding of *Biometrika* in many ways marks the start of the modern era of statistics; see, e.g., Stigler (1986), Porter (1988), Fienberg (1992), and Hald (1998).

Early in the twentieth century, some American researchers, but apparently no Canadians, came to see the applicability of the new mathematical statistics to their work and came to visit Pearson or to study with him at University College London. They came from a variety of disciplines: biology and evolution, economics, and psychology. Pearson's influence was also felt on American mathematics, albeit indirectly, as some studied his work and began to publish their own research in mathematical statistics. Until 1918, no Canadian mathematicians seem to have carried out any research in this area.

At the end of World War I, American mathematicians began to awaken to this newly emerging field. In his presidential address to a meeting of mathematical societies in the US, Edward Huntington of Harvard University addressed the topic of statistics (Huntington, 1919). He noted the paucity of papers on statistics read before the American Mathematical Society in the previous five years and that only a dozen professional mathematicians were members of the ASA. He encouraged more mathematicians to embrace work in statistical theory and then went on to give an overview of correlation and regression. An address to an American society would have had resonance in Canada. There was no Canadian Mathematical Society and many Canadian professional mathematics contacts were through the American societies. Consequently, no mathematical statistics courses, or at most very few, would be expected to appear at Canadian universities until about 1920. In England, important developments occurred throughout this period with contributions by towering statistical figures such as Ronald A. Fisher, Jerzy Neyman, Egon Pearson, and Harold Jeffreys who helped to create the foundations of statistics as we know it today.

In the US, the earliest department with statistics in its name was the Department of Biometry and Vital Statistics at Johns Hopkins University, created in 1918. The Statistical Laboratory at Iowa State College followed in 1933, and the Department of Statistics at George Washington University in 1935. Other departments often taught courses on probability and statistics, especially mathematics departments, with such notable intellectual leaders as Edwin Olds at Carnegie Tech, Harold Hotelling at Columbia, Henry Reitz

and Allen Craig at the University of Iowa, Harry Carver at the University of Michigan, and Samuel Wilks at Princeton University. They also provided much of the impetus behind the creation of the Institute of Mathematical Statistics (IMS) and *The Annals of Mathematical Statistics*, created by Carver and edited later by Wilks when it became the official journal of the IMS. The volume edited by Agresti and Meng (2013) documents the rise of academic departments of statistics in the US, during this and later periods.

In a somewhat parallel development, sample survey theory also emerged in the twentieth century; see Fienberg and Tanur (2001). In the 1930s, spurred on by Neyman's contributions in particular, statisticians at the US Bureau of the Census developed the first large-scale probability sampling approaches to measure unemployment, and for auxiliary information, as part of the 1940 decennial census. During this period, the Dominion Bureau of Statistics (DBS), now Statistics Canada, founded and led by Coats, focused on more traditional official statistical activities. Its move towards a probability-based labor force survey came in 1947, in an effort led by Nathan Keyfitz who went on to a second prolific career as a mathematical demographer in both Canada and the US, following his PhD work at the University of Chicago in the 1950s.

1.3 Statistical Education in Canada between the Wars

Relative to the US, the growth of statistics as an academic discipline in Canada was slow. In his address to the ASA, Coats (1939) commented on Helen Walker's study of statistics curricula (Walker, 1929) in the US. He remarked that, with respect to Canada,

“I grieve to say she would have found no chair of statistics, and that five of our twenty-two universities do not know the word in their curricula.”

Further, the first department in Canada to have “statistics” in its name was the Department of Actuarial Science and Statistics in 1950 at the University of Manitoba (Rankin, 2011); in the US it was 1918 at Johns Hopkins. Similar to most of the US, statistics in Canada grew in mathematics departments. Coats' lament is related, in part, to the size of the mathematics departments in Canada. Typically, these departments were small in size, sometimes comprising as few as two members and usually not more than about six. Toronto was the exception with faculty numbering into the double digits. This situation continued with only slight growth into the early 1950s.

Information on early statistics courses offered in mathematics departments can be obtained from university calendars of the time. The entries often, but not always, include the name of the instructor and the textbook used. We have used these calendars as a check on the claims about Canada's statistical pioneers. Edgett, for example, shows up in the Queen's calendars as a lecturer

in the 1931–32 academic year in which he taught “Mathematical Theory of Statistics,” two years earlier than the date claimed in Maag (1980). Over the next two years, Edgett taught the courses “Statistics and Probability” (1932–33) followed by “Probability and Statistics” (1933–34). No textbooks for the courses were mentioned. In addition to the courses by Edgett at Queen’s, we report on statistical courses from a selection of calendars that we have been able to examine.

At the University of Toronto, the first statistics course in the Department of Mathematics was offered at the graduate level in the 1917–18 academic year; the same course was offered yearly until about 1936. Initially, the course had the title “Actuarial science: Frequency curves and correlation,” showing Pearson’s impact on statistical education at this time. In the late 1920s the title changed to “Frequency curves and correlation, measurement of groups and series.” At the undergraduate level, a course “Mathematics of Statistics” was offered in 1924 at the pass level rather than at the honors level. The graduate course was taught continuously by Michael Mackenzie; presumably he taught the undergraduate course as well. No textbook was given for the undergraduate course until 1935 when Yule’s *Introduction to the Theory of Statistics* was put on the syllabus. Mackenzie (BA 1887 Toronto) obtained his MA in mathematics from Cambridge University. He became interested in actuarial science and taught the subject for many years at Toronto. He joined the Institute of Actuaries in 1899 and became a fellow of the Institute in 1907. Prior to Daniel DeLury’s arrival in the Department of Mathematics at Toronto in 1937, there were a couple of other developments in the statistics curriculum. In 1930 the mathematician Jacques Chapelon introduced a graduate course “The Mathematical Theory of Probability and Statistics” and the next year added another graduate course “The Fundamental Problems of Mathematical Statistics.” A few years later, the “Fundamental Problems” course was taken over by Norris Sheppard, another actuary teaching in the department. Toronto’s early experience in offering mathematical statistics courses is a harbinger for other universities that we were able to examine. Mathematicians who were interested in actuarial science and the mathematics of finance were often the developers and teachers of mathematical statistics courses. They obtained their highest degree abroad.

In the 1920s the University of Manitoba had a downtown campus where the Department of Mathematics and Astronomy was located. At first, courses with probability content were driven by actuarial science. In 1912 Professor Neil B. MacLean, whose interests were in geometry, offered a course in probability and life contingencies. Later, Lloyd Warren took over the actuarial courses and program, and in 1938 set up the new Department of Actuarial Science. In 1923, when still a member of the Department of Mathematics and Astronomy, Warren offered a graduate course in mathematical statistics with Yule’s book as the text. Like Michael Mackenzie, Warren was a Canadian who took his graduate degree in mathematics abroad, obtaining his PhD from the University of Chicago with a thesis topic far removed from actuar-

ial science. Manitoba had one thing that the University of Toronto did not have: an agricultural school which was located on a campus in Fort Garry where now almost the entire university sits. A course on the collection and analysis of data was offered in 1927 in the economics curriculum of the school and was followed the next year by a course in “advanced statistics.” A course on agronomic experimental methods using “biometrical methods of analyzing data” was offered in the Agronomy Department in 1928 by Gordon McRostie. When Cyril Goulden arrived in 1931, the course was named “Statistical Methods in Agronomic Research” and used R. A. Fisher’s *Statistical Methods for Research Workers* as the text. Goulden, a Canadian who took his PhD at the University of Minnesota in the genetics of wheat, spent a year at Rothamsted Experimental Station studying with Fisher. Goulden’s course is the earliest known example of Fisher’s influence on a statistics course offered in Canada. When the Department of Actuarial Science was founded in 1938, Goulden was transferred to the new department and the course was offered there under the name “Statistical Methods for Research Workers.” All statistics courses previously offered in mathematics were moved to the new department. In 1944, the department offered five courses in statistics, including Goulden’s course and another in mathematical statistics which used Wolfenden’s *Fundamental Principles of Mathematical Statistics*, a text intended for actuarial students. To reflect the growth of the statistics curriculum, the department’s name was changed to Actuarial Mathematics and Statistics in 1950.

We compare Manitoba’s situation to the University of Saskatchewan, which, like Manitoba, has a mathematics department and an agricultural school. Their first course in statistics was offered in the College of Agriculture as early as 1938. James Harrington, a Canadian crop scientist who took his PhD at Minnesota like Goulden, offered a course “Biometry and Field Plot Techniques.” The text for the course in 1939 was Goulden’s *Methods of Statistical Analysis*. The Department of Mathematics followed in 1940 with a course entitled “Introduction to the Mathematics of Statistics” with Kenny’s *Mathematics of Statistics* as the text. It is uncertain who taught this course. There were again some parallels to Manitoba and Toronto. A few years prior to 1940, the Department of Mathematics offered a course in the theory of investments which included topics in probability, life annuities and life insurance. In 1945 Waław Kozakiewicz joined the department and became the primary instructor for statistics. Following his arrival from Poland after World War II, Kozakiewicz worked initially at the DBS where he gave courses to the DBS personnel in pure and applied mathematics. In 1949 he was lured away from Saskatchewan by the Université de Montréal. This university was beginning to offer a program in mathematical statistics and wanted a mathematician trained in the French tradition to teach statistics (W.L.G.W., 1959).

The initial development of a statistics curriculum at University of Western Ontario is derivative from Manitoba. Harold Kingston, another Canadian who obtained his PhD in mathematics from the University of Chicago, joined Lloyd Warren on faculty at Manitoba. In 1921 Kingston was appointed pro-

fessor and chair of the Department of Mathematics and Astronomy at the University of Western Ontario. When Kingston arrived, there were only two or three faculty members in the department. The year following his appointment, Kingston began an actuarial program at Western and set up a course entitled "Introduction to Statistics." While statistics grew at Manitoba, it remained static at Western for many years. The introductory course was dropped after one year and another statistics course did not appear on the books until 1927. This time it was offered at the third year with Irving Gavett's *First Course in Statistical Method* as the text. It was mathematical but not at the level of Yule's introductory book. A follow-up course was added ten years later. The courses remained essentially service courses to the actuarial program well into the 1940s. The situation changed in the late 1940s after Randal Cole was hired in the department. In 1949 the text was changed to Hoel's *Introduction to Mathematical Statistics* and a graduate course in advanced statistics was offered. Cole's research area initially was differential equations. He did publish two papers in statistics, one in 1944 on biometry and the other in 1951 on order statistics.

The presence of an actuarial science program did not necessarily go hand-in-hand with the development of a statistics curriculum in a mathematics department. McGill was one university where there was difficulty in laying down early roots for the teaching of statistics in the Department of Mathematics. Herbert Tate arrived in the Department of Mathematics at McGill in 1921 after graduating with an MA in mathematics from the University of Dublin. The same year he became a fellow of the Royal Statistical Society. He taught courses related to actuarial science; one of the earliest courses in that area was "Probability, Finite Differences and Statistics" offered in 1924. Although Tate taught several courses related to actuarial science and wrote two books on the mathematics of finance, actuarial courses were offered only sporadically in the Department of Mathematics. What may have hampered the development of statistics courses in the Department of Mathematics is that the Department of Commerce also offered statistics and actuarial science courses nearly every year over the years 1922 to 1930. In 1922, Bowley's *Elements of Statistics* was one of the textbooks for the statistics course in commerce. The next year Yule's *Introduction to the Theory of Statistics* was added to the list. Tate also taught courses in the Department of Commerce from the mid-1920s onward. In 1927, and continuing for several years, a service course in elementary statistics was offered in the Department of Mathematics, first taught by another mathematician, T. H. Matthews. There was no further development of statistics courses in the Department of Mathematics even into the mid-1940s.

Of all the early pioneers, honorary member of the SSC or not, Daniel DeLury (BA Toronto 1929, PhD Toronto 1936) was the only one educated solely in Canada. DeLury taught first at the University of Saskatchewan and then at the University of Toronto, where he first appears as a lecturer in the Toronto calendar for 1938. He later went to the US and served on the Faculty

of Virginia Polytechnic Institute from 1945 to 1947 before returning to the Ontario Research Foundation in Toronto and later back to the University of Toronto, whose mathematics department he chaired.

1.4 World War II as a Watershed

In many ways, World War II was a watershed for statistics in the US as well as the UK. In both countries statisticians became part of the war effort as members of scientific research teams (Wallis, 1980; Barnard and Plackett, 1985; Fienberg, 1985, 2006). These concentrated activities led to major theoretical breakthroughs including the creation of sequential analysis (by Abraham Wald in the US and George Barnard in the UK), statistical decision theory and methods for quality control, and Bayesian tools used in code breaking efforts. Statisticians involved in these efforts went on to establish major departments in the US (Agresti and Meng, 2013) and active statistics groups and programs in various UK universities.

It is less well documented, but Canadian scientists were also involved in the war effort, particularly in the areas of operations research and quality control. There were about sixty Canadian scientists working in operations research scattered over the Canadian Army, the Royal Canadian Navy (RCN) and the Royal Canadian Air Force (RCAF); see Morton (1956). Among this group was John W. Hopkins, who completed an MSc in plant biochemistry at the University of Alberta in 1931, followed by a PhD under R. A. Fisher at University College London in 1934. Hopkins led a statistics laboratory at the National Research Council and during the war was seconded to the Eastern Air Command and Canadian Heavy Bomber Group (Fellegi, 1983). In quality control Isobel Loutit, who was working as a school teacher up to the end of 1941, responded to a Canadian government advertisement for women in science and mathematics to take jobs in industry. She initially worked for the Inspection Board of the United Kingdom and Canada, and then transferred to Northern Electric where she worked testing the quality of a mechanical aiming device for artillery (Bellhouse, 2002). This effort did not have the same effect on the growth of academic statistics programs as was the case in the US.

Another notable Canadian researcher closely linked to statistics was Howard B. Newcombe, who studied at Acadia and then in Trinidad before completing his PhD in genetics at McGill in 1939. Following service in the Royal Navy during World War II, he spent a year at Cold Spring Harbor in the US and then joined the Canadian Atomic Energy Project at Chalk River, Ontario. It was there that in addition to his genetics research he pioneered the development of record linkage techniques that influence government and academic statisticians in both Canada and the US.

A number of Canadians, who became statisticians at various universities, finished high school or an undergraduate degree and then served in the military during the war. This group includes Charles W. Dunnett (army), James L. McGregor (army), John R. McGregor (RCAF), Gilbert I. Paul (RCAF), Norman Shklov (army) and Ralph Wormleighton (army, medical corps).

1.5 A Second Early Generation of Canadian Statisticians

The next generation of Canadian statisticians received their undergraduate training during or just after World War II. They began their academic careers in a variety of disciplines, mainly mathematics, at various universities across the country. Given that there was very limited opportunity for doctoral studies at Canadian universities at this time, with one exception, they went abroad to complete their studies, mostly to the US but some to the UK. Again with one exception, they embraced statistics in their graduate programs. Most returned to Canada; the attraction of the US was stronger for later generations. Here we list some of the most notable of them in approximate chronological order of first degrees:

- Norman Shklov (BA 1940 Manitoba; MA 1949 Toronto). After PhD work at the University of Indiana, he served on the faculty of the University of Saskatchewan and later the University of Windsor.
- Charles W. Dunnett (BA 1942 McMaster; MA 1946 Toronto). He worked as a biostatistician in Canada and the US, receiving a PhD from the University of Edinburgh in 1960. He returned to McMaster in the 1970s (Macdonald, 1988).
- Ralph Bradley (BA 1944; MA 1946 Queen's). After a PhD in statistics from the University of North Carolina, he had a distinguished statistical career in the US at Virginia Polytech, Florida State, and Georgia.
- Colin Blyth (BA 1944 Queen's). After his PhD from the University of California at Berkeley in 1950, he taught at Illinois and returned to Queen's as a faculty member in the 1970s.
- Ralph Stanton (BA 1944 Western Ontario; MA 1945, PhD 1948 Toronto). He was more mathematician and computer scientist but exerted enormous influence on the development of statistics in Canada while on the faculties of Toronto, Waterloo, Manitoba, and Windsor.
- Martin Wilk (BEng 1945 McGill). After work at the National Research Council he stumbled into statistics as a graduate student at Iowa State University earning a PhD in 1955. His 25-year US career included Princeton University, Bell Laboratories, Rutgers University, and AT&T. In 1980

he returned to Canada as Chief Statistician (Genest and Brackstone, 2010).

- Jacques Saint-Pierre (MSc, LSc Montréal). He joined the Département de mathématiques at Université de Montréal in 1947 and obtained a PhD in statistics from the University of North Carolina in 1954. Remaining at Montréal for his career, he founded the Centre de statistique in 1957 and the Département d'informatique et de recherche opérationnelle in 1966.
- Donald Fraser (BA 1946, MA 1947 Toronto). He went to Princeton to study mathematics but gravitated into statistics under the influence of Sam Wilks and John Tukey, who were both in the Department of Mathematics. Following the receipt of his PhD in 1949, he returned to Toronto as a faculty member where he has spent the vast majority of his career. He has influenced generations of undergraduates and graduate students, some of whom followed his lead from Toronto to Princeton (DiCiccio and Thompson, 2004).
- James L. McGregor (BA 1949 MA 1951 British Columbia). He completed a PhD in mathematics at Caltech in 1954 and joined the faculty of Stanford University in mathematics, where he wrote a series of papers on stochastic processes in population genetics with Samuel Karlin.
- Ralph Wormleighton (MA Toronto). He went to Princeton where he completed a PhD in mathematics under John Tukey in 1955. He served on the Toronto faculty for 30 years beginning in 1953.
- Gilbert I. Paul (MSc Alberta). With an undergraduate background in plant breeding, he obtained a PhD in statistics and genetics from North Carolina State University in 1956. He taught population genetics at McGill for four years and then statistics at Manitoba for 30 years, where he influenced a stream of students to take advanced degrees in statistics.
- John McGregor (BSc, BEd, MEd Alberta). He went to England to study mathematical statistics at King's College Cambridge, from which he received a PhD in 1959. He returned to the Alberta faculty serving as chair of mathematics and dean of graduate studies before becoming the founding chair of the Department of Statistics and Applied Probability.

1.6 Generation of the 1950s and Early 1960s

In this generation, many Canadians continued to be attracted to graduate programs in statistics in the US. From the brief biographies of statisticians that we have examined from this time, the main attractors in the US were

Harvard, Princeton and Stanford. The major suppliers of students came from across the country: Alberta, British Columbia, Manitoba, McGill, Montréal, Queen's, Saskatchewan and Toronto. Here we document some of the graduates from that era, focusing on Canadians who took their undergraduate degrees in Canada and then went on to do graduate work abroad. Some of those returned to Canada, others did not but had strong Canadian connections, while yet others forged careers solely in the US.

1.6.1 Princeton Connection

One of the early US attractors for Canadian students was Princeton University. Samuel Wilks, John Tukey and William Feller were on staff at Princeton University, joined briefly by George Box and Frank Anscombe. What also helped to attract students, especially from Toronto, was the early connection made by Fraser and later by Wormleighton. Alexander Mood, one of Samuel Wilks' first students, related the following:

“In his later years [Wilks] maintained that it was impossible for him to persuade enough sufficiently promising college graduates to undertake work in statistics at Princeton and therefore he had to go to Britain and Canada to find good students whose attitudes had not been corrupted by pure mathematicians in the United States.” (Mood, 1965)

Many of the early Princeton Canadian students remained in the US after completing their PhD: Arthur Dempster (BA 1952; MA 1953 Toronto) on the faculty of Harvard; David Freedman (BSc McGill 1959) and David Brillinger (BSc Toronto 1959) on the faculty of the University of California at Berkeley; and Morton Brown (BS McGill 1962) at UCLA and Michigan. Although living and working in the US, Brillinger has long maintained strong Canadian connections and support for statistics in Canada; he has been President of the SSC and received the SSC Gold Medal. Several other Canadians who obtained their PhD from Princeton returned to Canada to work in academia or government. Thomas Wonnacott (BA Western Ontario 1957) returned as a faculty member in statistics to the University of Western Ontario where he wrote a popular introductory statistics textbook that influenced the teaching of statistics at many universities in the US and Canada. Morven Gentleman (BSc McGill 1963) has held positions in computer science at Waterloo and Dalhousie. James Ramsay (BEd Alberta 1964) studied psychology at Princeton and took a faculty position in psychometrics at McGill, and later was SSC president and Gold Medal winner. Gordon Sande (BSc Alberta 1964) briefly taught at Chicago and worked for a time at Statistics Canada on confidentiality and data disclosure issues.

Princeton also attracted Canadians as academic visitors, including Irwin Guttman (BSc 1951 McGill) and David Andrews (BSc 1965 Toronto). Guttman completed his PhD at Toronto in 1955 and Andrews in 1968, both under Fraser's supervision. Both were longtime faculty members in statis-

tics at Toronto, although Guttman also taught in the US at Wisconsin and the State University of New York at Buffalo. Both were awarded the SSC Gold Medal for their pioneering work in statistical theory and methods. Len Steinberg, whose PhD was also from Toronto under Fraser in 1967, taught at Princeton before joining the World Bank in Washington, DC. Miklós Csörgő, also an SSC Gold medalist, completed his PhD at McGill and did a post-doc at Princeton before returning to teach at McGill and Carleton.

William “Bill” Williams, was a McMaster undergraduate (BA 1954) and studied statistics at Iowa State (MS 1956; PhD 1958), returning briefly to teach at McMaster before joining Bell Labs, drawn by John Tukey who worked there as well as at Princeton, and later the faculty at Hunter College, City University of New York. Ronald Pyke also studied at McMaster overlapping with Williams, receiving his BA in 1953. He then migrated to the US, completing an MSc in Mathematical Statistics in 1955 and a PhD in Mathematics in 1956 at the University of Washington. After faculty appointments at Stanford and Columbia, he returned to Washington for the remainder of a distinguished career primarily focused on probability.

1.6.2 More Migration from Toronto

Many coming out of the honors courses in mathematics, statistics and chemistry at Toronto in the 1950s and early 1960s, went to US universities other than Princeton. Among the returnees to Canada, Thomas Stroud (BA 1956; MA 1960 Toronto) took his PhD in statistics from Stanford in 1968 and then joined the faculty at Queen’s. David W. Bacon (BA 1957 Toronto) joined Queen’s after obtaining his MS and PhD degrees in statistics from Wisconsin in 1962 and 1965, respectively. Paul Corey (BSc 1962; MSc 1965 Toronto) obtained his PhD in Biostatistics from Johns Hopkins University in 1974 and has been on the faculty in Public Health at Toronto since the late 1960s. After her PhD at the University of Illinois in 1969, Mary (Beattie) Thompson (BSc 1965; MSc 1966 Toronto) became a member of the statistics faculty at the University of Waterloo. Another SSC Gold Medal winner, she now leads the Canadian Statistical Sciences Institute. Larry Weldon (BSc 1965 Toronto) completed his PhD at Stanford in 1969 and returned to Canada to teach at York, then Toronto, and Dalhousie, and finally at Simon Fraser. Peter Macdonald (BSc 1966; MSc 1967) is the exception to the “study in the US rule.” He received his PhD in 1971 from the University of Oxford and then joined the faculty at McMaster University, in Hamilton.

Among the Toronto alumni, some notable statisticians decided to remain in the United States. John Chambers (BSc 1963 Toronto) went to Harvard for a PhD in statistics, which he completed in 1966. He joined the Bell Labs research staff in 1966 where he remained until his retirement in 2005, leading major efforts in statistical computing. He is currently on the faculty of Stanford University. Stephen Fienberg (BSc 1964 Toronto) followed Chambers to Harvard for his PhD in statistics, completed in 1968. He has taught subse-

quently at the University of Chicago, University of Minnesota, and Carnegie Mellon University, with a brief stint back in Canada at York University as Vice President Academic (1991–1993). Rudolph Beran (BSc 1964 Toronto) went to Johns Hopkins for his PhD, which he received in 1968. He then joined the statistics faculty of the University of California at Berkeley, and then moved to the University of California at Davis in 2001.

Several Canadian-trained undergraduates received PhDs in statistics from the University of Toronto in the late 1960s and migrated to the US as well. Hans Levenbach was born in Indonesia of Dutch parents at the beginning of World War II and came to Canada via the US. He attended Acadia (BSc in Physics and Math 1961), Queen's (MSc Electrical Engineering 1964), and Toronto (PhD 1968). He then joined Bell Labs and later founded an independent consulting company. Gerald van Belle was born in Holland, did all of his degrees at the Toronto (BA 1962, MA 1964, and PhD 1967), and then moved to the US initially to Florida State, and then to the University of Washington, in biostatistics. Andrew Kalotay was born in Hungary and immigrated to Canada following the 1956 revolution. His initial degrees were from Queen's (BA Math 1964, MS Math 1966) and he completed a PhD in statistics from Toronto 1968. He also went to Bell Labs and now focuses on problems of finance, leading his own company.

1.6.3 Manitoba Influence

When Gilbert Paul arrived at Manitoba, he became the head of the statistics group in the Department of Actuarial Mathematics and Statistics. In the early 1960s, he developed a Master's program in statistics and the first class graduated in 1963. Two of the three graduates were Charles Goldsmith and Brian Macpherson, both coming from Manitoba's undergraduate program (Rankin, 2011). Goldsmith went on to take his PhD at Paul's alma mater, North Carolina State. He graduated in 1969 and returned to Canada to a position at McMaster University. MacPherson remained in the department at Manitoba and subsequently obtained his PhD at Iowa State in 1981. Bruce Johnston (BSc Manitoba 1960) also took his PhD at North Carolina State, graduating in 1968. He returned to Canada, initially to Queen's University, and then back to Manitoba. Other Manitoba students were attracted to Harvard. Paul Switzer (BSc 1960 Manitoba) went to Harvard where he completed a PhD under Arthur Dempster, and then joined the faculty at Stanford where he has spent his career. Aaron Tenenbein (BSc 1965 Manitoba) and Allan Donner (BSc 1965; MSc 1967 Manitoba) were classmates and both studied with William Cochran at Harvard. Tenenbein completed his PhD in 1969 and joined the faculty at New York University. Donner completed his PhD in 1971 and returned to Canada to take a position in biostatistics at the University of Western Ontario, where he has become well known for his work in clinical trials. The connection that the Department of Actuarial Mathematics and Statistics had to Manitoba's business school probably led George Alexander Whitmore

to go to the University of Minnesota to take his MSc and PhD (1968) in business following his undergraduate work at Manitoba. He returned to Canada initially to teach at Saskatchewan, and later at McGill in Montréal.

1.6.4 Other Notable Canadians Who Went Abroad

Like many others, French-language universities in Canada had a mixed experience sending students abroad. The Université de Montréal established its own PhD program and Alexis Zinger was its first statistics PhD student in 1957 (Rousseau, 2000). Zinger went on to become “Vice-recteur aux Communications” at UQAM. The mixed experience is seen in four notable undergraduate students. André Plante went to Toronto to obtain his PhD in 1962; Pierre Robillard and Robert Côté went to the University of North Carolina, graduating in 1968 and 1971, respectively; as for Robert Cléroux, he stayed in Québec and obtained his PhD from the Université de Montréal in 1965. André Plante was a Professor at UQAM for the better part of his career. Prior to his untimely death, Pierre Robillard was a central figure in trying to bring the two Canadian statistical societies together in the 1970s (Bellhouse and Genest, 1999); the SSC annual best thesis award is named after him. After his PhD, Robert Côté returned to Université Laval, where he had done his undergraduate studies; he helped to develop a very successful undergraduate program in statistics and was Chair of the Department of Mathematics and Statistics for several years. Cléroux was a Professor at the Université de Montréal and served as President of the SSC in 1988–89.

There were at least two students from Kingston who went on to the United States for graduate studies. Jack Graham (BSc 1955 Queen’s) went to Iowa State University where he obtained his PhD in 1963. Upon returning to Canada he taught at Carleton for many years. Roger Davidson (BSc 1960 Queen’s; MA 1961 Toronto) obtained his PhD from Florida State under Ralph Bradley. On his return to Canada, he taught at the University of Victoria.

Another two students bound for studies in the United States came out of McGill — one came back, the other did not. Donald Dawson (BSc 1958; MSc 1959 McGill) completed his PhD at MIT in 1963. He returned to Canada and taught at McGill before moving to Carleton in 1970. Edward Rothman (BSc 1965 McGill) went to Johns Hopkins for a PhD in 1969, after which he joined the University of Michigan.

Saskatchewan also produced two students. Ian MacNeill (BEd 1958; BA 1962 Saskatchewan; MSc 1964 Queen’s) studied at Stanford, receiving his PhD in 1967. He founded the Department of Statistical and Actuarial Sciences at University of Western Ontario in 1980. James Tompkins (BA 1965 Saskatchewan) went on to do graduate studies at Purdue (MS 1967; PhD 1970). He taught at the University of Regina on his return to Canada and devoted much energy to promoting the SSC.

Other universities at this time produced a single but notable graduate who continued his studies, with one exception, in the US. The exception is Don-

ald Watts (BSc 1956; MSc 1958 British Columbia) who went to Imperial College to obtain his PhD in 1962. He taught at the University of Wisconsin (1966–70) before taking a faculty position at Queen’s University. James Zidek (BSc 1961; MSc 1962 Alberta) received his PhD from Stanford in 1967. He then joined the faculty at UBC where he remained for his entire career, and was a founding member of its Department of Statistics in 1983. Christopher Field (BSc 1964 Dalhousie) went to Northwestern where he obtained his PhD in 1968, before returning to the Dalhousie faculty where he became the leader of the statistics group within Dalhousie’s Department of Mathematics. Both Zidek and Field were SSC presidents and Gold Medal winners. One person returned after a long hiatus. David Thomson (BSc 1965 Acadia) studied at the Polytechnic Institute of Brooklyn, where he received his PhD in 1971 in electrical engineering. Following a long career at Bell Laboratories, he returned to Canada to teach at Queen’s in 2001. And there was another who got away. Barry Arnold (BSc 1961 McMaster) did his graduate work in statistics at Stanford (MS 1963; PhD 1965) and is a long-time faculty member at the University of California at Riverside.

As DeLury was the exception to out-of-country study in the 1930s and 1940s, there were also exceptions in the 1950s and 1960s, e.g., Andrews, Csörgő, and Guttman. David Sprott also studied at Toronto in mathematics (BA 1952; MA 1953) and completed a 1955 PhD there under DeLury, followed by postdoctoral study at the Galton Laboratory at University College London. After three years on the faculty at Toronto, he joined the fledgling program at Waterloo, where he remained for his entire career as a researcher and administrator. Ivan Fellegi completed three years of university in Hungary before emigrating to Canada in 1956 at the time of the Hungarian uprising. He joined the staff of DBS/Statistics Canada and completed his studies with night courses at Carleton, where he was the first MSc (1958) and PhD (1961) recipient. He spent his entire career at Statistics Canada, succeeding Martin Wilk as Chief Statistician in 1985, and serving until retirement in 2008.

1.7 A Paradigm Shift

From the 1910s to the 1960s, many Canadians went abroad to do their graduate work in statistics (or mathematics), the vast bulk of them to the United States. Beginning in the 1960s the whole dynamic began to change as departments in Canada developed and many began producing PhD graduates in statistics, initially in Montréal and Toronto. Both Canadians and students from other countries entered these programs. Many, both Canadian-born and not Canadian-born, remained in Canada enhancing the statistics profession in general and the faculty at Canadian universities in particular. Further, with the explosion in the size and number of Canadian universities in the 1960s and

beyond, several statisticians were brought into Canada from other countries to take faculty positions in statistics, as well as many other disciplines. Many of these “imports” have contributed greatly to statistics in Canada. The general growth of the discipline can be seen in the creation of separate departments of statistics, with Manitoba and Waterloo leading the way in 1967. Later, several departments with the name “Department of Mathematics” were renamed to “Department of Mathematics and Statistics.”

Although the development of statistics as a discipline in Canada lagged behind that in the US, the same could well be said for other academic disciplines. But what should be clear from this brief exposition is that the generations of statisticians who trained initially as undergraduates in Canada, and then went abroad for graduate study, mostly to the US, went on to shape the course of statistics as a field in Canada, and to some extent in the US as well.

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We are grateful for the help provided by librarians and archivists at various universities in obtaining access to early university calendars. Unfortunately there was no systematic way to trace the paths of undergraduates from Canada to the US and elsewhere in the 1945–65 period, and we relied on others for assistance and information. Everything worth knowing turns out *not* to be easily available from a Google search. A number of old friends and colleagues graciously assisted us by identifying and helping track down information on Canadians who began their careers with an undergraduate education in Canada; but we are sure our coverage is incomplete.

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