

# Comparing Research Output and Impact of Canadian Business Schools in OR Journals

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We have recently conducted a major study to quantify both the output and the impact of the past decade's scholarly research carried out by those academics currently employed by Canadian business schools, using journal paper counts and citation analysis. The study is summarized in the web site "A Citation-based Comparison of Research Impact by Canadian Business Schools" which is located at <http://www.bus.ualberta.ca/citationstudy2/>. There is a short paper linked to this site (see "Future Work"), and a more comprehensive paper has been submitted to an academic journal for publication. The major conclusions of the study are:

- the per capita paper output in Canadian business schools is relatively low and is declining,
- there are significant differences across Canadian business schools, and
- the paper and citation credits are highly variable, with a few "stars" producing most of the impact.

This brief CORS Bulletin article will focus on the aspects of the study that are of most interest to CORS members.

The study uses paper counts as a measure of research output and citation counts as a measure of intellectual impact. To conduct our study, we generated a list of faculty members in all Canadian business schools, performed a full search using the ISI citation database (<http://woscanada.isihost.com/>) for every faculty member to extract the number of papers co-authored and the number of citations received for these papers during the 1990-1999 period. We divided the paper and citation counts by the number of authors (resulting in "credits"), and we credited them to the current employer of the researcher. Some shortcomings of the study, which are detailed in the academic paper, are as follows:

- There are many well-known problems with using citation counts to estimate impact. (For example, self-citations, clique-citations, and review articles perturb counts.)
- The source publications database does not contain all research outlets; for example books and conference proceedings are excluded.
- The database does not index all academic journals, and some journals are only indexed for part of the study period. For example *Journal of Operations Management* is not indexed for the 1990-1999 period.
- Citing authors may misquote a reference by using an incorrect spelling of the name, an incorrect (or missing) volume or page number, or an incorrect publication year.

Our study considers 2,505 faculty members currently employed by 60 business schools in Canada. These academics have authored or co-authored a total of 4,577 journal articles in 778 ISI-indexed journals during the period 1990-1999. The total number of confirmable citations to these papers (as of May, 2001) is 22,013. The 2,505 academics included in the study received a total of 2,910 paper credits (1.16 paper credits/person) and 13,632 citation credits (5.44 citation credits/person). The averages for just those 1,154 academics who actually published something in those 10 years in an ISI-indexed journal are 2.5 paper credits/person and 11.8 citation credits/person.

Here are some of the results of the study, which are likely to be of interest to members of CORS:

- Among the 778 journals, the one where the most papers by all Canadian business professors have been published is the *European Journal of Operational Research* (164 papers).
- The list of the top 10 journals (in terms of the number of papers by Canadian academics) also contains *Journal of Operational Research Society* (#4), *Management Science* (#6), *Operations Research* (#7), and *Operations Research Letters* (#10). With 5 journals in the top 10, operations research is well represented in paper counts.

- In a comparison of the number of papers published by Canadian business academics in the top two or three journals in each field, our area (counting papers in *Operations Research* and *Management Science* only) leads all other areas with 65 co-authored papers per journal in ten years (comparable figures: strategy: 30, marketing: 17, finance: 17, accounting: 11). (The seeming superiority of our area may be somewhat deceptive since *Management Science* publishes papers in all functional areas.)

The ISI citation index has a classification of journals into disciplines. For the purposes of this article we limit ourselves to the following classifications, which contain most of the journals CORS members would publish in:

- industrial engineering and manufacturing engineering
- operations research and management science
- applied mathematics, statistics and probability

While there are 308 journals in these classifications, Canadian business academics have co-authored papers in only 120 of them. The number of paper credits for Canadians business academics in these journals is 737.5, and 70% of these credits are concentrated in only 20 of these journals. Using this database, we rank Canadian business schools with respect to total citation credits received as follows (listing only those with 50 or more citation credits).

University	Citation Credits	Paper Credits	Citations/Paper
McMaster	528.2	91.4	5.8
HEC	520.7	60.1	8.7
UBC	314.9	63.3	5.0
Laval	255.5	46.7	5.5
York	148.2	30.2	4.9
Memorial	127.3	13.4	9.5
McGill	117.2	23.4	5.0
Western	106.3	15.3	7.0
Concordia	103.1	36.7	2.8
Carleton	100.5	11.8	8.5
UNB Fred.	96.2	37.9	2.5
Windsor	93.5	18.2	5.1
Dalhousie	86.2	9.1	9.5
Waterloo	84.9	27.9	3.0
Alberta	75.6	32.8	2.3
Calgary	70.8	26.8	2.6
Toronto	68.2	38.3	1.8
Queen's	67.6	15.0	4.5
UQAM	58.5	14.0	4.2

Note that there are very significant differences between these schools—an order of magnitude difference between the top and the bottom. Also, the citation/paper counts differ significantly from a high of 9.5 for Dalhousie to a low of 1.8 for Toronto. Four schools are distinctly separated from the rest: McMaster, HEC, UBC, and Laval. McMaster has the most paper and citation credits. However, HEC has almost as many citation credits as McMaster with two-thirds of the paper credits.

These rankings are based on a very large number of journals. One might be interested in the rankings produced by a smaller set of well-known journals. We produce a second ranking by selecting the following seven journals (relevant paper counts in parentheses): *European Journal of Operational Research* (164), *Journal of Operational Research Society* (79), *Management Science* (72), *Operations Research* (57), *International Journal of Production Research* (44), *IIE Transactions* (43), and *Mathematical Programming* (15).

There are a total of 274 paper credits and 1,881 citation credits for our study in the 474 papers published in these journals. In the second table we only list the eleven schools with a minimum of 50 citation credits and 5 paper credits for the 1990-1999 period.

The same four schools stand out as before, but the rankings between them are different. Laval has the most papers in these seven journals, yet HEC has 50% more citation credits than Laval with only two-thirds as many papers.

We generate a final ranking by focusing only on papers published in *Operations Research*. In this elite category, two schools stand head-and-shoulders above the rest: UBC and HEC. UBC has the most paper credits with 7.2 (to HEC's 5.6), but HEC has the most citation credits (more than twice as many as UBC) with 111.5.

University	Citation Credits	Paper Credits
HEC	368.7	22.0
Laval	240.2	34.3
UBC	173.8	21.8
McMaster	146.7	29.6
York	112.5	14.3
Western	83.3	8.8
Concordia	76.9	16.3
Windsor	72.0	9.5
Memorial	67.5	5.0
McGill	62.7	6.6
UNB Fred.	55.2	16.5

We end this brief article with a summary of the results and some observations.

- While the rankings depend on the criterion and the journal set used, in aggregate HEC seems to be the research leader in OR among Canadian business schools when we consider all three rankings summarized above.
- The rankings reported here do not take department size into account. There are significant differences in department sizes even among the schools near the top. While 30 individuals have paper credits at HEC, this number is only 16 for Laval. (Note that these numbers may be larger than department sizes since individuals in other areas may also publish in the target journals.)
- The top four schools (HEC, UBC, Laval, and McMaster) each have fairly large and stable management science groups with productive Ph.D. programs, and traditionally management science has enjoyed a strong position in these business schools.
- It is of interest that some of the business schools with high-ranking MBA programs are not near the top. For example, McGill and Western rank below the top five, and Toronto and Queen's are much further below. This is probably due to the emphasis placed by these schools on management science and the size of their management science groups.
- Some schools rank highly based on the accomplishments of a single individual. For example, almost all of citation credits of Memorial (sixth in the first ranking) are due to one individual. Likewise 84% of all citation credits of Carleton (tenth in the first table) are due to one person. The loss of such an individual to retirement would have a severe impact on the school's rank.
- A "star effect" is visible in most groups where the great majority of all paper and citation credits are due to a small number of individuals. For example, although 30 different individuals have paper credits at HEC, 55% of the 520.7 citation credits reported in the first table are due to one individual. Likewise, over half of the Laval citation credits are due to one person.
- The most balanced distribution of citation credits is observed for UBC where no one has over 15% of the citation credits and 10 of the 20 individuals with paper credits have over 5% of the total citation credits from the first table.
- The research output of the current Canadian business faculty in OR/IE/Stat journals increases gradually between 1990 and 1995 and then decreases gradually. The annual number of paper credits goes from a low of 58.8 credits in 1990 to a high of 89.4 in 1995, and then goes down to 70.3 in 1999.
- About 25% of all paper credits in the study come from journals where quantitative methods groups publish (OR/IE/Stats). Given that the percentage of individuals in our area is about 17% (according to the CFBSD web site), we can claim that the quantitative methods groups are above-average producers of research papers in Canadian business schools.
- For some business schools, the majority of the citation credits are due to their quantitative group. For example, 72% of Laval's school credits and 59% of McMaster's school credits are generated through papers in quantitative areas.
- For benchmarking purposes, we also considered the business schools of Georgia (a top-40 school) and Michigan (a top-10 school). In the second table (based on seven journals) Georgia would rank 6<sup>th</sup> in citation credits and 5<sup>th</sup> in paper credits. Michigan would rank 3<sup>rd</sup> in both. This limited benchmarking exercise against two well-known and large US public schools lends some support to the assertion that some Canadian OR groups are indeed world-class.