Measuring Academic Research in Canada: Field-Normalized Academic Rankings 2012

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Introduction

The purpose of this document is to provide an alternative way of measuring research strength at Canadian universities. Though research is clearly not the only dimension on which one would want to judge a university—teaching quality, student outcomes and contributions to the community are obviously important as well—it is nevertheless a very important element of institutional activity. In most universities in Canada, 40% of academic staff time is (at least nominally) supposed to be devoted to research activities. Measuring performance in this area is therefore an important step on the road to examining overall productivity and performance in the sector.

Determining which metric to use to accurately capture the essence of institutional research output is not entirely straightforward. All metrics have both strengths and weaknesses associated with them. For example, *publication* counts are one of the most-often used indicators of research prowess. This indicator has the very salient advantage of being relatively easy to obtain. Its disadvantages are (1) that it does not distinguish between the *quality* of publications (a publication which languishes un-cited in an obscure journal is given the same weight as a highly-cited paper in *Science* or *Nature*) and (2) when used to measure institutional performance, it tends to reward schools which are strong in disciplines with very active publication cultures and penalizes schools with more faculty members in disciplines with less active publication cultures. As a result, in many of the international rankings, an average professor in a department like physics might be worth a dozen professors in most of the humanities in terms of their contribution to the overall figures.

Analyzing *citations* rather than publications sidesteps the central problem of publication counts by only rewarding research that is consistently recognized by other faculty. The problem of disciplinary bias, however, remains; individual researchers' records can be massively affected by a single highly-cited paper. There is also the minor problem that citations analyses cannot distinguish between papers cited approvingly and those cited as being mistaken or erroneous.

One method sometimes used to limit the distortions of abnormal publication or citation data is to use *H-index scores*. These scores are equal to "the largest possible number *n* for which *n* of a researcher's publications have been cited at least *n* times." They therefore avoid some of the problems associated with both publications and citations: large numbers of un-cited papers will not result in a higher index, and a single, highly-cited paper cannot by itself skew an H-index score. What is rewarded instead is a large number of well-cited papers—a measure, in essence, of consistent impact. Two common criticisms of the H-index are (1) that it is somewhat backwards-looking, rewarding good papers that have been in circulation a long time (a charge which can to some extent be made of publications and citations counts as well but is more true of the H-index) and (2) that it, too, suffers from the same problems of disciplinary bias as publications and citations measures.

Often, *research Income* from public granting councils and/or private sources is used as a measure of research excellence. Sometimes, this data is presented as a raw, aggregate figure per institution, and sometimes it is divided by the number of faculty members to create a measure of income per faculty member. Of course, the actual value or quality of research may not have much to do with the amount of money involved in research grants. Not all fields of study intrinsically require the same amount of capital in order to conduct research. Research in economics, for instance, typically requires money for IT and data acquisition (and of course graduate students)—expensive, possibly, but a small fraction of the infrastructure sometimes used in high-energy physics or cutting-edge biomedicine.

Patents/Commercialization Income are also sometimes used as measures of research "outputs." Many of the issues about research funding crop up here, too, even though one is an input and the other an output; high income from patents and commercialization is often closely connected to performance in specific disciplines like biomedicine, electrical engineering and computer science rather than performance across a broader set of disciplines.

As should be obvious from this brief round-up, a key problem with research output measurement systems is the issue of *field neutrality*. That is to say, that not all fields of research are alike. Physicists tend to publish and cite more than historians, and the average value of the public-sector research grants available to them are also larger, too. As a result, in rankings based on traditional metrics—such as the ones by *Research InfoSource* in its annual ranking of Canada's Top 50 Research Universities—"good" universities may simply be the ones with strengths in fields with high average grants and citation counts. Obviously, there may be a degree of auto-correlation at play; universities that are good at the "money" disciplines are likely also good in non-money disciplines as well. But that is mere supposition—existing Canadian research metrics assume this rather than demonstrate it.

Another, perhaps less obvious issue, is the degree to which different measurements capture different aspects of research strength. All publication-based measures are to some degree backward-looking in that they look at evidence of past accomplishments. This can be partially mitigated by limiting the publication period to five or ten years, but the point remains to some extent. Research income, on the other hand, is a much more current or even future-oriented measure of research strength. These are both important measures of performance that best reflect actual performance when used in tandem.

In order to best analyze institutional research performance, a combination of metrics should be designed with the following characteristics:

- Measures of historical performance in research (which can be thought of as measuring an institution's stock of knowledge, or "academic capital") should be balanced with measures of current or potential strength.
- Bias towards particular disciplines with high capital requirements for research and high publication/citation cultures need to be minimized. In other words, metrics should be field-neutral.

With these characteristics in mind, HESA has developed a new set of metrics for comparing and ranking research output at Canadian institutions, which we present in the following pages.

Methodology

This exercise uses two sources of data to compare the research performance of Canadian universities.

In order to measure an institution's "academic capital," we chose a bibliometric measure which measures both overall productivity and impact; namely, the H-index. Data for this measure was obtained through HESA's proprietary H-index Benchmarking of Academic Research (HiBAR) database (see Appendix B for more details on HiBAR and how it was compiled). Using this data, it is possible to determine publication norms in each discipline, simply by averaging the H-index scores of all the academics belonging to departments in each discipline or field of study.[1] Each academic's H-index score was then normalized by dividing it by this national average. These field-normalized normalized scores can then be averaged at an institutional level. This ensures that schools do not receive an undue advantage simply by being particularly good in a few disciplines with high publication and citation cultures.

In order to measure "current strength," we chose to use grants from the federal granting councils as an indicator. In this exercise, we use granting council expenditures for the year 2010-11, obtained directly from NSERC and SSHRC (see Appendix A for details). Note that we use expenditures rather than awards; that is to say, we include all money from single-year grants awarded in 2010-11 in addition to payments in the current year for multi-year grants, but exclude money awarded this year which is to be disbursed in future years, and money awarded in prior years which was disbursed in prior years. An "average" grant per professor figure is derived by summing the total amount of granting council awards given to professors in each academic discipline and then dividing it by the number of researchers in that field. A normalized score for each department at each institution is then derived by dividing the amount of money awarded to researchers in that department by the product of the national average grant per professor and the number of professors in the department.

In other types of rankings, the lack of field-normalization tends to bias results towards institutions which have strength in disciplines which have more aggressive publication and citation cultures and in which research is expensive to conduct—in particular physics and the life sciences. The process of field-normalizing both the H-index and granting council results removes these biases and allows the performance of academics to be judged simply against the norms of their own disciplines. To achieve results in field-normalized rankings, institutions cannot simply rely on a strong performance in a few select disciplines. Instead, breadth of excellence is required.

Using this field-normalized data, the rankings were constructed as follows:

1) The data was divided into two groups: the natural sciences and engineering, and the social sciences and humanities. While it would be possible to simply report an aggregate normalized score across all disciplines, showing results separately more clearly allows institutions that have

[1] This process is described in more detailin our previous paper on this subject, Jarvey, P., A. Usher and L. McElroy. 2012. *Making Research Count: Analyzing Canadian Academic Publishing Cultures*. Toronto: Higher Education Strategy Associates. A summary of the methodology is furthermore included in Appendix B.

specialized in one or the other area to show their relative strengths. Medical and health-related disciplines are excluded from this study (see box below).

2) In both broad fields, we rank institutions on both their H-index results and their granting council results. Scores in each ranking are derived by giving the top discipline 100 points and awarding points to every other institution in direct proportion to their results.
3) An overall ranking in both fields is created by summing the scores given in the H-index and granting council awards rankings (i.e., each is weighted at 50%).

One final note about this methodology is in order. In most rankings, the denominator for the majority of indicators is the institution—publications per institution, research dollars per institution, etc. Implicitly, this methodology favours larger institutions, since they have more researchers who can bring in money. In our methodology, the denominator is the number of professors at an institution. This changes the equation somewhat, as it reduces the advantage of size. Other methodologies favour large absolute numbers; ours favours high average numbers. The two methodologies do not provide completely different pictures: in Canada, the largest institutions tend to attract the most research-intensive faculty, so big institutions tend to have high average productivity, too. But they are not identical, either.

Why is Medicine Excluded From This Study?

The reason we do not include medicine in these rankings is simply that different institutions have different practices in terms of how they list “staff” in medicine. Some institutions tend to list a relatively small number of staff; others appear to include virtually every medical researcher at every hospital located within a 50-mile radius of the university. Some are good at distinguishing between academic faculty and clinicians, and others are not. Thus, while we are able to calculate H-index data on all individuals listed by institutions as staff, an apples-to-apples comparison is clearly impossible.

We recognize that this exclusion means that our results necessarily will understate the institution-wide performance levels of those universities that demonstrate true excellence in medical fields. The University of Toronto, in particular, appears weaker overall in this exercise than it would if medicine were included.

If it were in our power to include medical disciplines, we would do so; however, at this time, it is impossible.

Results—Science and Engineering

For science and engineering, we present data on all institutions which listed more than 30 active academics on the websites in science and engineering disciplines.[2]

We began by looking at the average normalized institutional H-index scores, which are shown in Table 1 (following page). A score of one on this measure means that the average professor at that institution has an H-index exactly equal to the national average in his or her discipline. The University of British Columbia scores top overall at 1.51, followed extremely closely by the University of Toronto (St. George) and l'Université de Montreal, where average H-index scores were 1.50. McGill and Simon Fraser are fourth and fifth, some distance behind (1.33 and 1.31, respectively).

Perhaps the most surprising positions in the H-index rankings are those of two small universities, l'Université du Québec à Rimouski (1.20, tenth overall) and Trent University (1.16, twelfth overall). These institutions come ahead of some much larger and more prestigious universities, including Laval, Alberta and Western. These results highlight the difference between an approach which uses institutions as a denominator and those which use professors as a denominator, as well as the importance of field normalization. Rimouski gets a very high score because of the very high productivity of its researchers specializing in marine sciences. Trent gets a high overall ranking because all of its professors have an H-index of at least one, meaning that they each have at least one cited paper in the Google Scholars database. In comparison, at most U-15 schools, about one in ten scientists have no such paper. In other publication comparisons, these schools tend to do well either because of their sheer size, or because they happen to have some strength in disciplines which have higher levels of citations and publication; normalizing for size and field removes these advantages and hence reveal a different set of "top" institutions.

Table 2 (following pages) compares average field-normalized funds received through NSERC. A score of one on this measure means that the average research grant per professor is exactly equal to the national average research grant per professor in that discipline. This list contains fewer surprises, in that the schools that one traditionally thinks of as having strong research traditions (i.e., the U-15) tend to come higher up the list. The University of British Columbia again comes first. Montreal and Toronto remain in the top five, accompanied by Ottawa and Alberta. Saskatchewan, in eighth, would actually have come second had we elected to include the Major Research Projects funding envelope in the calculations (we did not, partly because of the distorting nature of the data and partly because the funding envelope was recently cut). Rimouski, again, manages to come in the top ten, again because of the very strong performance of its marine scientists.

[2] See Appendix A for more details.

Table 1: Science and engineering discipline-normalized bibliometric (H-index) scores

Rank	Institution	Count	Mean Standardized Score	Points
1	UBC	611	1.509	100.00
2	Toronto - St. George	1118	1.504	99.72
3	Montreal	345	1.500	99.41
4	McGill	685	1.327	87.97
5	Simon Fraser	364	1.306	86.55
6	Waterloo	776	1.257	83.34
7	Ottawa	267	1.254	83.15
8	York	280	1.208	80.06
9	Queen's	409	1.200	79.53
10	UQ Rimouski	88	1.200	79.53
11	McMaster	440	1.197	79.36
12	Trent	90	1.160	76.88
13	Toronto - Scarborough	130	1.153	76.40
14	Manitoba	460	1.057	70.09
15	UQ Trois-Rivières	109	1.054	69.85
16	Alberta	659	1.026	68.01
17	Western	374	0.996	66.04
18	Concordia	250	0.992	65.76
19	Laval	457	0.989	65.54
20	UQ Montreal	287	0.967	64.06
21	Calgary	385	0.960	63.63
22	Saskatchewan	413	0.928	61.53
23	Victoria	390	0.885	58.63
24	Guelph	455	0.868	57.54
25	Toronto - Mississauga	82	0.835	55.35
26	Memorial	367	0.833	55.25
27	UNBC	51	0.827	54.82
28	Carleton	279	0.823	54.55
29	UQ Chicoutimi	70	0.804	53.30
30	Windsor	208	0.795	52.67
31	UBC - Okanagan	102	0.737	48.83
32	Dalhousie	479	0.722	47.89
33	Bishop's	38	0.677	44.85
34	University of New Brunswick	282	0.668	44.26
35	Saint Mary's	95	0.663	43.98
36	Laurentian	130	0.663	43.92
37	Sherbrooke	331	0.643	42.63
38	Wilfrid Laurier	88	0.633	41.97
39	Mount Allison	43	0.608	40.31
40	Lakehead	193	0.591	39.16
41	UOIT	141	0.576	38.18
42	Lethbridge	173	0.575	38.10
43	Brandon	35	0.548	36.30
44	Regina	122	0.542	35.93
45	St. FX	112	0.494	32.75
46	Ryerson	282	0.493	32.70
47	ETS	137	0.478	31.69
48	UPEI	75	0.462	30.61
49	Winnipeg	110	0.393	26.08
50	Acadia	83	0.378	25.05
51	Cape Breton	33	0.314	20.80
52	Brock	80	0.300	19.87
53	Mount Saint Vincent	39	0.286	18.98
54	Thompson Rivers	99	0.251	16.65
55	Moncton	109	0.221	14.63

Table 2: Science and engineering discipline-normalized funding scores

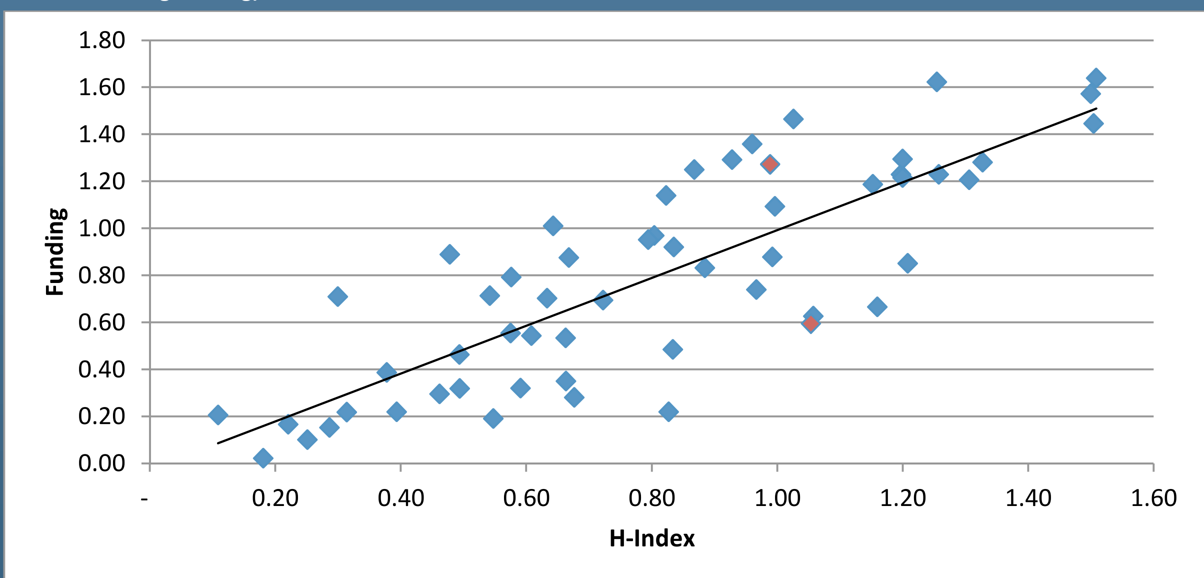
Rank	Institution	Normalized Funding Amount (new)	Points
1.00	UBC	1.640	100.00
2.00	Ottawa	1.623	98.95
3.00	Montreal	1.572	95.86
4.00	Alberta	1.465	89.33
5.00	Toronto-St. George	1.447	88.21
6.00	Calgary	1.359	82.89
7.00	UQ Rimouski	1.295	78.95
8.00	Saskatchewan	1.292	78.77
9.00	McGill	1.281	78.13
10.00	Laval	1.272	77.56
11.00	Guelph	1.250	76.22
12.00	McMaster	1.230	74.99
13.00	Waterloo	1.229	74.94
14.00	Queen's	1.216	74.17
15.00	Simon Fraser	1.206	73.52
16.00	Toronto-Scarborough	1.187	72.39
17.00	Carleton	1.139	69.46
18.00	Western	1.093	66.65
19.00	Sherbrooke	1.011	61.63
20.00	UQ Chicoutimi	0.969	59.09
21.00	Windsor	0.951	58.02
22.00	Toronto-Mississauga	0.920	56.10
23.00	ETS	0.889	54.21
24.00	Concordia	0.879	53.58
25.00	New Brunswick	0.875	53.35
26.00	York	0.851	51.88
27.00	Victoria	0.832	50.76
28.00	UBC - Okanagan	0.800	48.78
29	UOIT	0.792	48.32
30	UQ Montreal	0.739	45.08
31	Regina	0.714	43.53
32	Brock	0.709	43.23
33	Wilfrid Laurier	0.703	42.86
34	Dalhousie	0.694	42.33
35	Trent	0.666	40.63
36	Manitoba	0.626	38.20
37	UQ Trois-Rivières	0.594	36.21
38	Lethbridge	0.554	33.80
39	Mount Allison	0.543	33.12
40	Laurentian	0.534	32.55
41	Memorial	0.484	29.52
42	Ryerson	0.463	28.20
43	Acadia	0.387	23.60
44	Saint Mary's	0.349	21.31
45	Lakehead	0.320	19.48
46	St. FX	0.319	19.43
47	UPEI	0.295	18.01
48	Bishop's	0.280	17.10
49	Winnipeg	0.219	13.36
50	UNBC	0.219	13.35
51	Cape Breton	0.217	13.25
52	Brandon	0.191	11.63
53	Moncton	0.167	10.17
54	Mount Saint Vincent	0.152	9.26
55	Thompson Rivers	0.101	6.17

Understanding the relationship between bibliometric and funding scores in the natural sciences and engineering

As Figure 1 shows, there is a generally positive correlation between bibliometric and funding indicators of institutional research strength. This is to be expected—indeed, it would be deeply worrying if such a relationship did not exist. However, while the general relationship holds, there are numerous outliers.

In Figure 1, institutions represented by dots below the line are those that have high H-index counts relative to the amount of funding they receives, while those above the line receive high levels of funding given their H-index counts. An interesting comparison can be made, for instance, between Laval and UQTR. Trois-Rivières' field-normalized H-index scores in NSERC disciplines are slightly better than Laval's (1.05 vs. 0.99), yet Laval receives field-normalized granting council funding at over well over twice UQTR's rate (1.27 vs. 0.59). It is not at all clear why this happens.

Figure 1: Correlation between Field-Normalized H-Index Scores and Field-Normalized Granting Council Funding (natural sciences and engineering)



Among schools with substantial research presences, Laval, Ottawa, Calgary, Saskatchewan, Sherbrooke, Guelph and Alberta all receive substantially more money in granting council funds on a field-normalized basis than one would expect given their bibliometric performance. Conversely, Simon Fraser, Concordia, York, Manitoba, Trent, Toronto (St. George), UQAM and Memorial all receive substantially less money than one would expect given their bibliometric performance.

Table 3 provides the overall rankings for engineering and sciences. The first column presents the institutional scores from Table 1, while the second presents scores from Table 2. The total score is simply an average of the two previous scores.

Unsurprisingly, since it topped both of the previous tables, The University of British Columbia comes first overall, with a score of 100, fractionally ahead of l'Université de Montréal (for purposes of this comparison, l'École Polytechnique is included as part of U de M) at 97.63, and the University of Toronto (St. George) at 93.97.[3] Fourth and fifth places belong to Ottawa and McGill.

There is some distance between the top five and the rest of the pack; after Simon Fraser, in sixth place, the gap between university scores become much smaller. There is little, for instance, to distinguish between seventh-place Rimouski, eighth-place Waterloo or ninth-place Alberta. McMaster University rounds out the top ten.

From a high level, the list of top science and engineering universities looks a lot like one would expect, in that thirteen of the top fifteen schools are in the U-15 (though one—Toronto—is represented twice because of the strong performance of the Scarborough campus). It is, however, the exceptions that draw the eye. Rimouski in seventh position is an amazing result, as is Scarborough in twelfth (ahead of Calgary) and, to a lesser degree, Trent in 21st.

[3] If Toronto were considered as a single university, its overall score would drop to just under 90, but the school would remain in third place overall.

Table 3:Total normalized scores (natural sciences and engineering)

Rank	Institution	H-index	Funding	Total Score
1	UBC	100.00	100.00	100.00
2	Montreal	99.41	95.86	97.63
3	Toronto - St.George	99.72	88.21	93.97
4	Ottawa	83.15	98.95	91.05
5	McGill	87.97	78.13	83.05
6	SFU	86.55	73.52	80.04
7	UQ Rimouski	79.53	78.95	79.24
8	Waterloo	83.34	74.94	79.14
9	Alberta	68.01	89.33	78.67
10	McMaster	79.36	74.99	77.18
11	Queen's	79.53	74.17	76.85
12	Toronto - Scarborough	76.40	72.39	74.40
13	Calgary	63.63	82.89	73.26
14	Laval	65.54	77.56	71.55
15	Saskatchewan	61.53	78.77	70.15
16	Guelph	57.54	76.22	66.88
17	Western	66.04	66.65	66.34
18	York	80.06	51.88	65.97
19	Carleton	54.55	69.46	62.01
20	Concordia	65.76	53.58	59.67
21	Trent	76.88	40.63	58.76
22	UQ Chicoutimi	53.30	59.09	56.19
23	Toronto - Mississauga	55.35	56.10	55.72
24	Windsor	52.67	58.02	55.34
25	Victoria	58.63	50.76	54.69
26	UQ Montreal	64.06	45.08	54.57
27	Manitoba	70.09	38.20	54.14
28	UQ Trois-Rivières	69.85	36.21	53.03
29	Sherbrooke	42.63	61.63	52.13
30	UBC - Okanagan	48.83	48.78	48.81
31	UNB	44.26	53.35	48.80
32	Dalhousie	47.89	42.33	45.11
33	UOIT	38.18	48.32	43.25
34	ETS	31.69	54.21	42.95
35	Wilfrid Laurier	41.97	42.86	42.42
36	Memorial	55.25	29.52	42.38
37	Regina	35.93	43.53	39.73
38	Laurentian	43.92	32.55	38.24
39	Mount Allison	40.31	33.12	36.71
40	Lethbridge	38.10	33.80	35.95
41	UNBC	54.82	13.35	34.08
42	Saint Mary's	43.98	21.31	32.64
43	Brock	19.87	43.23	31.55
44	Bishop's	44.85	17.10	30.97
45	Ryerson	32.70	28.20	30.45
46	Lakehead	39.16	19.48	29.32
47	St. FX	32.75	19.43	26.09
48	Acadia	25.05	23.60	24.32
49	UPEI	30.61	18.01	24.31
50	Brandon	36.30	11.63	23.96
51	Winnipeg	26.08	13.36	19.72
52	Cape Breton	20.80	13.25	17.03
53	Mount Saint Vincent	18.98	9.26	14.12
54	Moncton	14.63	10.17	12.40
55	Thompson Rivers	16.65	6.17	11.41

Results—Social Science and Humanities

Table 4 shows each institution's average normalized institutional H-index scores. The University of British Columbia comes first on this measure by some considerable distance. Essentially, what the H-index score for UBC (1.93) says is that the *average* professor at that university has a record of publication productivity and impact which is twice the national average for their discipline; some, of course, have scores which are considerably higher.

Following some distance behind this are the University of Toronto (1.67) and McGill (1.63), followed more distantly by Queen's University (1.53). There is then another substantial gap between Queen's and the next two institutions, Alberta (1.37) and McMaster (1.36). Rounding out the top ten are three more Ontario institutions (York, Guelph and Waterloo—the latter two somewhat surprisingly since they are better known for their science and engineering), plus Simon Fraser University in British Columbia.

One thing to note here is that the Quebec universities do significantly less well in these comparisons than they did in science and engineering. The reason for this is almost certainly linguistic. The H-index, by design, only looks at publications that receive citations. Francophone academics publishing in French may produce the same volume of work as someone publishing in English, but they are speaking to a much smaller worldwide audience and therefore their work is substantially less likely to be cited by others. This is not as much of a concern in science and engineering because these disciplines have a tradition of publishing in English. In the social sciences and the humanities, however, French is still widely used as a means of scholarly communication, with negative consequences for bibliometric comparisons such as this one. To get a sense of how important the linguistic factor is, if we were to treat the École des Hautes Études Commerciales—a business school where scholars for the most part publish in English—as a separate institution, it would come eleventh overall, substantially higher than any other francophone institution (conversely, without HEC, Montreal would fall from 18th to 21st overall).

Table 4: Social sciences and humanities bibliometric (H-index) scores

Rank	Institution	Count	Mean Standardized Score	Points
1	UBC	995	1.927	100.00
2	Toronto - St. George	1799	1.674	86.89
3	McGill	814	1.629	84.52
4	Queen's	621	1.533	79.56
5	Alberta	713	1.370	71.12
6	McMaster	456	1.364	70.78
7	York	1112	1.331	69.06
8	Guelph	309	1.320	68.50
9	Simon Fraser	846	1.312	68.09
10	Waterloo	568	1.289	66.91
11	Concordia	577	1.244	64.55
12	Trent	290	1.238	64.23
13	Toronto-Mississauga	369	1.219	63.29
14	Toronto-Scarborough	305	1.192	61.86
15	Carleton	614	1.162	60.31
16	Manitoba	609	1.130	58.66
17	Montréal	1309	1.096	56.86
18	Calgary	690	1.070	55.51
19	Saskatchewan	459	1.054	54.72
20	Western	1071	1.016	52.72
21	Victoria	759	1.008	52.33
22	Dalhousie	480	1.007	52.24
23	UOIT	130	0.980	50.88
24	Windsor	422	0.964	50.02
25	Wilfrid Laurier	514	0.945	49.06
26	UPEI	148	0.874	45.35
27	UBC -Okanagan	170	0.851	44.18
28	Ottawa	1436	0.845	43.86
29	Mount Saint Vincent	142	0.844	43.82
30	Brock	424	0.829	43.00
31	Memorial	407	0.808	41.93

Rank	Institution	Count	Mean Standardized Score	Points
32	UQ Trois-Rivières	325	0.792	41.09
33	Lethbridge	311	0.787	40.84
34	UQ - Montreal	2473	0.728	37.77
35	Ryerson	726	0.724	37.59
36	UQ - Rimouski	171	0.721	37.43
37	Thompson Rivers	232	0.690	35.82
38	Acadia	147	0.680	35.27
39	New Brunswick	311	0.668	34.68
40	Laval	1534	0.668	34.65
41	Brandon	136	0.660	34.24
42	Lakehead	200	0.651	33.78
43	Regina	329	0.647	33.59
44	St. Thomas	183	0.639	33.15
45	Winnipeg	275	0.623	32.31
46	UNBC	147	0.617	32.02
47	Sherbrooke	504	0.592	30.71
48	Saint Mary's	321	0.585	30.36
49	Fraser Valley	117	0.583	30.26
50	Laurentian	299	0.560	29.05
51	Moncton	218	0.537	27.88
52	St. FX	208	0.515	26.71
53	Athabasca	98	0.511	26.53
54	Cape Breton	105	0.506	26.28
55	UQ - Chicoutimi	144	0.483	25.08
56	Mount Allison	153	0.468	24.28
57	Bishop's	114	0.444	23.06
58	King’s (NS)	163	0.428	22.20
59	Nipissing	198	0.387	20.11
60	Royal Roads	240	0.214	11.09
61	OCAD	134	0.189	9.83

Table 5: Social sciences and humanities discipline-normalized funding scores

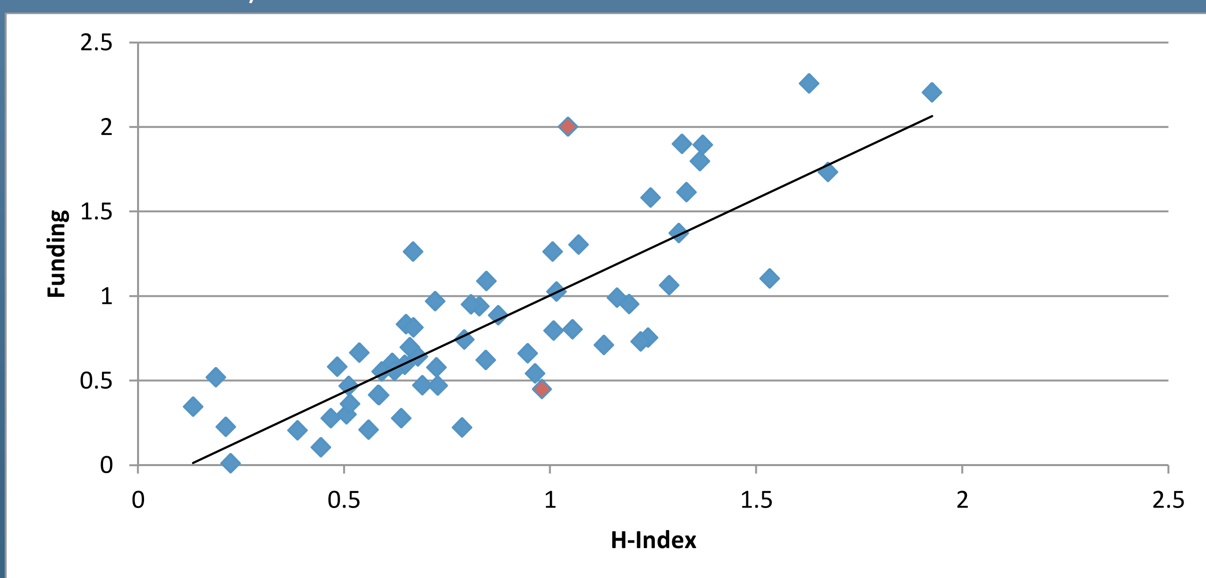
Rank	Institution	SSHRC - Funding	Score
1	McGill	2.258	100.00
2	UBC	2.206	97.67
3	Montréal	1.944	86.08
4	Guelph	1.901	84.19
5	Alberta	1.895	83.91
6	McMaster	1.799	79.66
7	Toronto-St. George	1.733	76.77
8	York	1.615	71.51
9	Concordia	1.582	70.08
10	Simon Fraser	1.372	60.78
11	Calgary	1.305	57.79
12	Dalhousie	1.263	55.94
13	Laval	1.263	55.93
14	Queen's	1.105	48.95
15	Ottawa	1.090	48.26
16	Waterloo	1.065	47.15
17	Carleton	0.991	43.88
18	UQ - Rimouski	0.971	43.00
19	Toronto-Scarborough	0.953	42.20
20	Western	0.951	42.13
21	Memorial	0.951	42.13
22	Brock	0.941	41.66
23	UPEI	0.886	39.26
24	Lakehead	0.834	36.94
25	New Brunswick	0.815	36.09
26	Saskatchewan	0.804	35.62
27	Victoria	0.796	35.27
28	Trent	0.755	33.42
29	UQ – Trois-Rivières	0.744	32.95
30	Toronto-Mississauga	0.733	32.44
31	Manitoba	0.710	31.46
32	Brandon	0.698	30.93
33	Moncton	0.666	29.51
34	Wilfrid Laurier	0.662	29.30
35	UBC - Okanagan	0.660	29.24
36	Acadia	0.643	28.46
37	Mount Saint Vincent	0.622	27.53
38	UNBC	0.605	26.78
39	Regina	0.594	26.32
40	UQ - Chicoutimi	0.582	25.76
41	Ryerson	0.578	25.60
42	Winnipeg	0.559	24.74
43	Sherbrooke	0.553	24.50
44	Windsor	0.542	24.01
45	OCAD	0.520	23.01
46	Thompson Rivers	0.473	20.96
47	UQ - Montreal	0.471	20.88
48	Athabasca	0.469	20.79
49	UOIT	0.450	19.92
50	Fraser Valley	0.416	18.43
51	Saint Mary's	0.414	18.34
52	St. FX	0.363	16.10
53	Cape Breton	0.301	13.33
54	Mount Allison	0.278	12.30
55	St. Thomas	0.277	12.28
56	Royal Roads	0.227	10.04
57	Lethbridge	0.223	9.87
58	Laurentian	0.210	9.31
59	Nipissing	0.206	9.12
60	Bishop's	0.107	4.72
61	King's (NS)	0.000	0.00

Table 5 (above) shows each institution's field-normalized granting council income in social sciences and humanities. There is substantially more variation in institutional scores on this indicator than the equivalent one in sciences and engineering, largely because a far smaller proportion of academics in SSHRC-related fields receive grants than do those in NSERC-related fields. McGill comes first on this measure (2.258), followed closely by the University of British Columbia (2.206) and l'Université de Montréal (1.944). Guelph—which tends to be thought of as stronger in the sciences than in the social sciences and humanities—is fourth, followed by the University of Alberta.

Understanding the Relationship between Bibliometric and Funding Scores in the Social Sciences and Humanities

As in sciences and engineering, there is a generally positive correlation between bibliometric indicators of institutional research strength and granting council ones. But as with sciences and engineering, there is also some significant variation around the mean as well. L'Université de Montréal, for example, has normalized funding scores which are twice its normalized H-index scores (2.00 and 1.04), while UOIT, which has a very similar bibliometric performance to Montreal's, has a normalized funding performance only one-quarter as strong (0.44 and 0.98).

Figure 2: Correlation between Field-Normalized H-Index Scores and Field-Normalized Granting Council Funding (social sciences and humanities)



Among schools with substantial research presences, McGill, Laval, Guelph, Alberta, Montreal and McMaster all receive substantially more money in granting council funds on a field-normalized basis than one would expect given their bibliometric performance. Conversely, Queen's, Trent and Toronto (Mississauga) all receive substantially less money than one would expect given their bibliometric performance.

Table 6 provides the overall rankings for humanities and social sciences. The first column presents the institutional scores from Table 4, while the second presents scores from Table 5. The total score is simply an average of the two previous scores.

As was the case with sciences and engineering, The University of British Columbia comes first overall, with a score of 98.84, ahead of McGill (92.26) and Toronto (81.83). Alberta is fourth at 77.52, followed by Montreal (including HEC) and Guelph with nearly identical scores (76.60 and 76.35, respectively).

In the social sciences and humanities, the dominance of the U-15 is somewhat less than it is in sciences and engineering. Of the top ten universities in this field, four are from outside the U-15 (Guelph, York, Concordia and Simon Fraser). On the other hand, the top scores are restricted to schools with large enrolments; there is no equivalent to Rimouski's performance in science in this field. The best small university performance is that of Trent, in 18th.

Table 6: Overall scores

Rank	Institution	H-Index	Funding	Total
1	UBC	100.00	97.67	98.84
2	McGill	84.52	100.00	92.26
3	Toronto-St. George	86.89	76.77	81.83
4	Alberta	71.12	83.91	77.52
5	Guelph	68.50	84.19	76.35
6	Montreal	64.55	86.08	75.32
7	Mcmaster	70.78	79.66	75.22
8	York	69.06	71.51	70.29
9	Concordia	64.23	70.08	67.15
10	SFU	68.09	60.78	64.44
11	Queen's	79.56	48.95	64.25
12	Waterloo	66.91	47.15	57.03
13	Calgary	55.51	57.79	56.65
14	Dalhousie	52.24	55.94	54.09
15	Carleton	58.66	43.88	51.27
16	Toronto - Scarborough	60.31	42.20	51.26
17	Trent	63.29	33.42	48.36
18	Western	52.72	42.13	47.42
19	Toronto - Mississauga	61.86	32.44	47.15
20	Ottawa	43.86	48.26	46.06
21	Laval	34.65	55.93	45.29
22	Saskatchewan	54.72	35.62	45.17
23	Manitoba	56.86	31.46	44.16
24	Victoria	52.33	35.27	43.80
25	UOIT	50.88	19.92	35.40
26	Windsor	50.02	24.01	37.02
27	Wilfrid Laurier	49.06	29.30	39.18
28	Brock	43.00	41.66	42.33
29	UPEI	45.35	39.26	42.31
30	Memorial	41.93	42.13	42.03
31	UQ Rimouski	37.43	43.00	40.22
32	UQ Trois-Rivieres	41.09	32.95	37.02
33	UBC - Okanagan	44.18	29.24	36.71
34	Mount Saint Vincent	43.82	27.53	35.68
35	Lakehead	33.78	36.94	35.36
36	Brandon	34.24	30.93	32.59
37	Acadia	35.27	28.46	31.86
38	Ryerson	37.59	25.60	31.59
39	UNB	34.68	26.78	30.73
40	Thompson Rivers	35.82	20.96	28.39
41	Regina	33.59	26.32	29.96
42	UNBC	32.02	26.78	29.40
43	UQ Montreal	37.77	20.88	29.32
44	Moncton	27.88	29.51	28.70
45	Winnipeg	32.31	24.74	28.53
46	Sherbrooke	30.71	24.50	27.61
47	UQ Chicoutimi	25.08	25.76	25.42
48	Lethbridge	40.84	9.87	25.35
49	Saint Mary's University	30.36	18.34	24.35
50	Fraser Valley	30.26	18.43	24.34
51	Athabasca	26.53	20.79	23.66
52	St. Thomas	33.15	12.28	22.72
53	St. FX	26.71	16.10	21.41
54	Cape Breton	26.28	13.33	19.80
55	Laurentian	29.05	9.31	19.18
56	Mount Allison	24.28	12.30	18.29
57	OCAD	9.83	23.01	16.42
58	Nipissing	20.11	9.12	14.62
59	Bishop's	23.06	4.72	13.89
60	King’s (NS)	22.20	-	11.10
61	Royal Roads	11.09	10.04	10.57

Conclusion—What These Rankings Tell Us

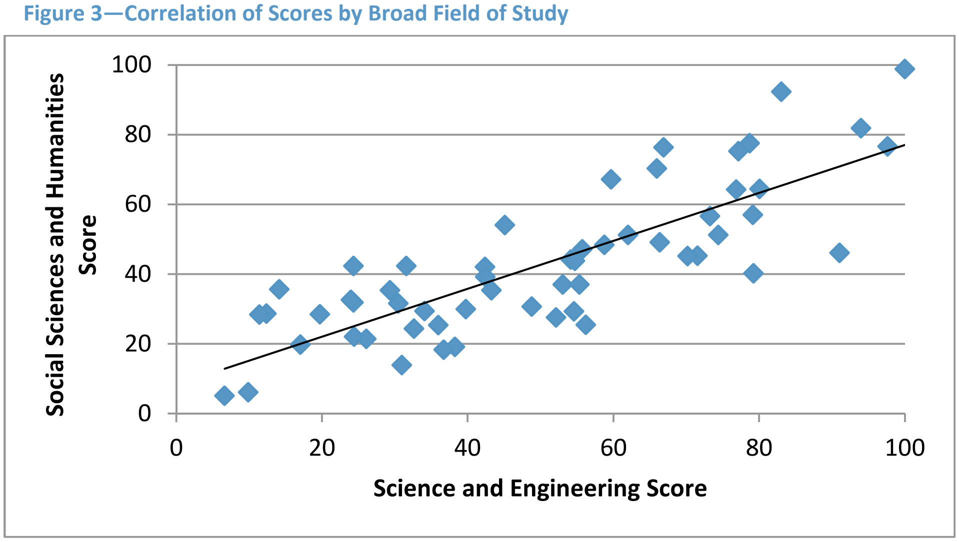
Table 7 recaps briefly the top ten in each of the two broad fields. The University of British Columbia comes a clear first in both. McGill and Toronto come in the top five in both categories; Montreal, Simon Fraser, Alberta and McMaster all make the top ten in both.

Table 7: Summary of results (top ten)

Rank	Science and Engineering	Social Sciences and Humanities
1	UBC	UBC
2	Montreal	McGill
3	Toronto - St. George	Toronto - St. George
4	Ottawa	Alberta
5	McGill	Guelph
6	Simon Fraser	Montreal
7	UQ Rimouski	McMaster
8	Waterloo	York
9	Alberta	Concordia
10	McMaster	Simon Fraser

Strength in social sciences and humanities is generally correlated with strength in science and engineering. As Figure 3 shows, few institutions display strength in one but not the other. There are exceptions, of course; Rimouski, Ottawa and Chicoutimi have much better scores in NSERC disciplines than in SSHRC ones, but this is an artifact of the fact that so many of their social science and humanities publications are in French, where citations are less common. The only examples of schools with substantially better records in SSHRC disciplines than NSERC ones tend to be small, like UPEI or Bishop's.

Figure 3—Correlation of Scores by Broad Field of Study



Perhaps the main thing that has been learned in this exercise is that stripping away the effects of institutional size and field-normalizing bibliometrics and grant awards results in a slightly different picture of university performance than what we are used to. Big, research-intensive institutions still do well: UBC, McGill Montreal and Toronto still make up four of the top five spots in both broad science/engineering and social sciences/humanities. But there are some surprises nonetheless: Guelph cracks the top ten in social sciences, and Rimouski cracks the top ten in science, Simon Fraser makes the top ten in both and the U-15 do not by any means form a monopoly of the top spots in either field.

In other words, if one can be bothered to look behind the big, ugly institution-wide aggregates that have become the norm in Canadian research metrics, one can find some little clusters of excellence across the country that are deserving of greater recognition. If this publication has succeeded in providing Canadian policymakers with a slightly more nuanced view of institutional performance, then it will have served its purpose.

Appendix A—Technical Notes

Inclusion Criteria for Institutions

All universities in Canada were eligible for inclusion. For inclusion in the science and engineering rankings, an institution had to have a minimum of 30 academics working in these disciplines; for social sciences and humanities rankings, the minimum was set at 50 academics. These numbers used for these counts were sourced from the HiBAR database, which excludes emeriti, sessional instructors, adjuncts, and graduate students. It was not possible to confirm accurate faculty counts for Mount Royal University, and for University de Québec en Abitibi-Témiscamingue. For this reason, both these institutions have been intentionally excluded from this ranking.

Second, only faculty teaching in degree programs were included, on the rationale that research plays a much smaller role for faculty teaching professional short-term programs, including trades, certificates, and diploma programs. A few examples of excluded programs include Legal Administrative Assistant and Court Reporting. There were a small number of institutions at which these kinds of programs formed an extensive part of the program offerings, but where it was impossible to identify which professors taught in these programs. We chose to exclude four such institutions (Grant MacEwan University, Kwantlen Polytechnic University, Vancouver Island University, and Université de Saint-Boniface) for these reasons, as we felt that the resulting score would give an exaggeratedly weak picture of their existing research efforts.

Affiliated schools (e.g., Brescia, King's and Huron at Western) are reported as part of their parent institutions. Institutions with multiple campuses, where the secondary campus is essentially a single faculty (e.g., McGill's Macdonald campus in Ste. Anne de Bellevue, or Waterloo's Architecture campus in Cambridge) are reported as a single institution, as are institutions with multiple campuses where the faculty numbers at the secondary campus is too small to be included independently. Where an institution has multiple geographically separate multi-faculty campuses of sufficient size to be included (e.g., the University of Toronto campuses, or UBC-Okanagan), they are reported separately. The only exception to this rule is the University of New Brunswick, where, because of a problem with our own database of faculty members, we are unable to split the data properly. We apologize for this.

List of Disciplines

In order to perform field-normalization, it was necessary to classify all academics (or, more accurately, the departments for whom they worked), into one of a number of standardized disciplines. The disciplines used for this process are as follows:

Agricultural sciences
- Agricultural biology
- Agricultural and food supply economics
- Agricultural and environmental studies
- Food and nutritional sciences
- Forestry
- Animal and Livestock Sciences
- Natural resources management

Business
- Accounting
- Administration
- Business economics
- Finance
- Human resources
- Information management
- International business
- Management
- Marketing
- Tourism

Design and related disciplines
- Architecture
- Environmental design
- Fashion design
- Industrial design
- Interior design
- Landscape design
- Marketing and advertising design
- Urban planning and related disciplines

Engineering
- Aerospace engineering
- Biological engineering
- Chemical engineering
- Civil engineering
- Electrical and computer engineering
- Environmental engineering
- Geomatics
- Materials engineering
- Mechanical engineering
- Ocean and naval engineering
- Physical engineering
- Process engineering
- Systems engineering

Fine arts
- Aboriginal fine arts
- Art history
- Dance
- Film
- Music
- Theater
- Visual arts
- Graduate Studies

Humanities
- Classics
- Cultural studies and related area studies
- English and literature
- English Language Learning
- History
- International cultural studies
- Other languages
- Philosophy

Science
- Astronomy
- Atmospheric science
- Biology
- Chemistry
- Computer science
- Environmental science
- Geology
- Mathematics and statistics
- Neuroscience
- Physics, astrophysics, and astronomy

Social Sciences
- Aboriginal Studies
- Anthropology
- Archeology
- Area studies
- Canadian studies
- Culture and communications
- Criminology
- Development Studies and Developmental Economics
- Economics
- Environmental Studies
- Gender and women's studies
- Geography
- International Relations
- Linguistics
- Political science
- Psychology
- Public policy studies
- Religious studies
- Sociology
- Social work
- Theology

Other
- Education
- Journalism
- Law
- Library sciences

SSHRC and NSERC Funding Inclusion Rules

NSERC and SSHRC funding was based on annual data on award recipients that is made publicly available by both institutions. Award amounts included in the database reflect total amounts paid out in 2010, regardless of the original year of competition of the award, or the total amount of the award (thus inly including the current year's fraction of multi-year awards. Award programs that can only be won by students or postgraduates were intentionally excluded (such as Vanier scholarships, the NSERC Postgraduate Scholarships Program, and SSHRC Doctoral Fellowships, for example). Institutional grants were included, with the one exception of the NSERC Major Resources Support program. While this award contributes to institutional research funding, the fact that it is distributed in massive one-time investments directed towards a narrow group of researchers gives it powerful influence over ranked outcomes, without indicating long-term research potential of the institution. For example, two awards totaling 19 million dollars was disbursed to the Canadian Light Source at the University of Saskatchewan in 2010. This constitutes more than half of all NSERC funding at U of S in 2010.

Awards that were excluded included:

SSHRC
Banting Postdoctoral Fellowships
CGS Michael Smith Foreign Study Supplements
Doctoral Awards
Joseph-Armand Bombardier CGS Master's Scholarships
Sport Participation Research Initiative (Doctoral Supplements)
Sport Participation Research Initiative (Research Grants)
SSHRC Postdoctoral Fellowships
Vanier Canada Graduate Scholarships
President's Awards

NSERC
Major Resources Support Program
Aboriginal Ambassadors in the Natural Sciences and Engineering Supplement Program
Environment Canada Atmospheric and Meteorological Undergraduate Supplements
Undergraduate Student Research Awards
Industrial Undergraduate Student Research Awards
Alexander Graham Bell Canada Graduate Scholarships Program
Michael Smith Foreign Study Supplements Program
Industrial Postgraduate Scholarships Program
NSERC Postgraduate Scholarships Program
Summer Programs in Japan or Taiwan
Vanier Canada Graduate Scholarships Program
Banting Postdoctoral Fellowships Program
Industrial R&D Fellowships Program

Japan Society for the Promotion of Science Postdoctoral Fellowships
Postdoctoral Fellowships Program
Postdoctoral Supplements
Visiting Fellowships in Canadian Government Laboratories Program

Appendix B—HiBAR Methodology

Over the course of eight month in fall 2011 and spring 2012, HESA developed the HiBAR database – a citation database containing the publication records of approximately 50,000 academic staff at Canadian institutions. This database contains both the current institution (and department) of employment of each scholar, and their publication record.

This database can be used to calculate normalized measures of academic impact. The process of building the HiBAR database and deriving normalized measures is discussed in detail in the following pages, and depicted visually on Page 2.

Process Summary

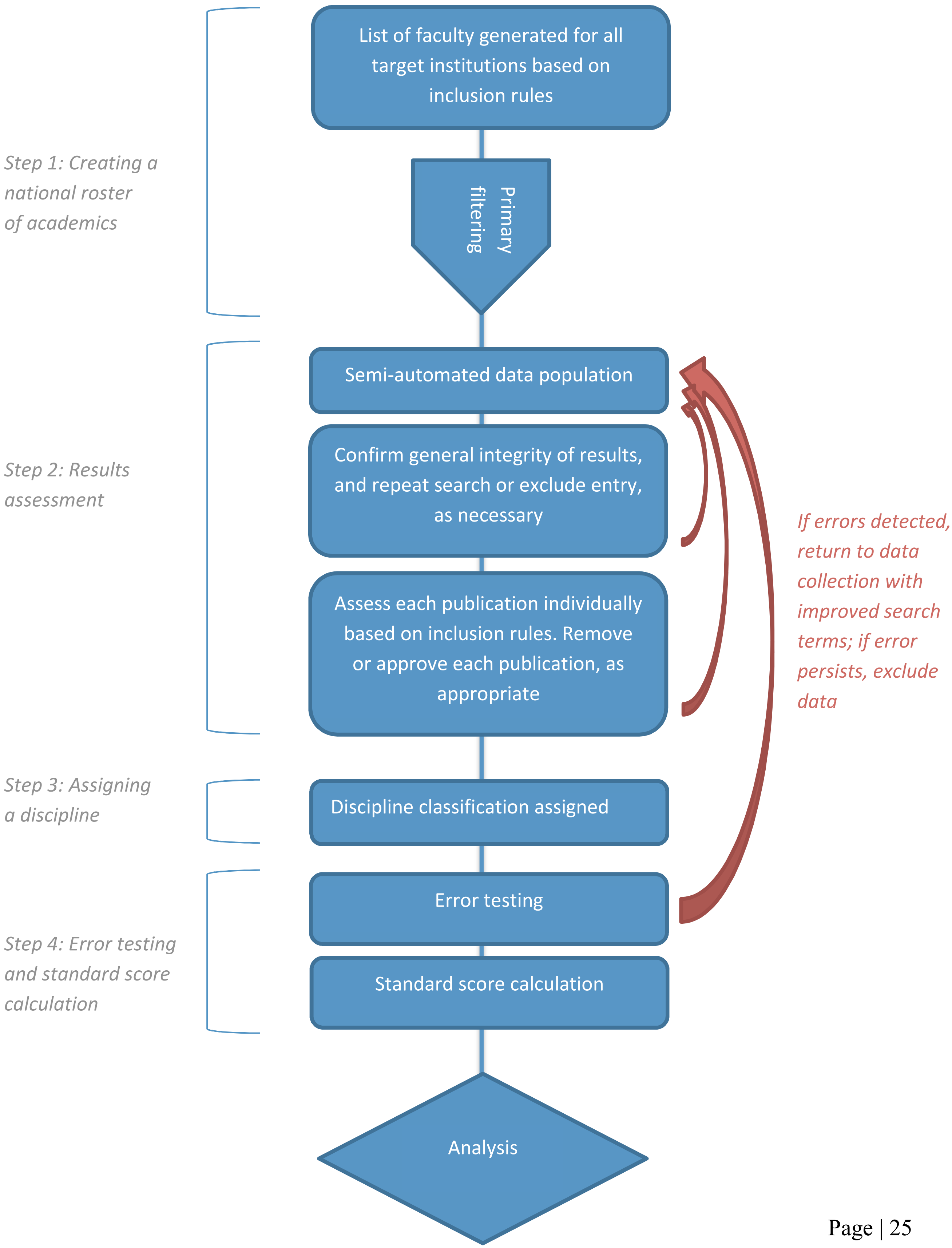
To determine disciplinary publication norms that can be used for discipline-normalization, HESA began by constructing a complete roster of academic staff at Canadian universities, using institution and department websites.

HESA then derived an H-index score for each academic by feeding each name into a program that uses Google Scholar to calculate an H-index value.

HESA then applied quality-control techniques (including manual review of every record) to reduce the number of false positives, correct metadata problems, and ensure that only desired publication types were included.

To confirm the data quality, H-index scores for each scholar were then tested for error.

Finally, scores for every faculty member were normalized by dividing raw H-index scores by the average score of the discipline in which each scholar is active, creating a measure of performance relative to the performance standards of each discipline. These normalized scores were then used to crease institutional averages.


List of faculty generated for all target institutions based on inclusion rules
Primary filtering
Step 1: Creating a national roster of academics
Semi-automated data population
Confirm general integrity of results, and repeat search or exclude entry, as necessary
Assess each publication individually based on inclusion rules. Remove or approve each publication, as appropriate
Step 2: Results assessment
If errors detected, return to data collection with improved search terms; if error persists, exclude data
Discipline classification assigned
Step 3: Assigning a discipline
Error testing
Standard score calculation
Step 4: Error testing and standard score calculation
Analysis

Step 1: Creating a national roster of academics

The first step was to generate a roster of academics that would be included in calculation of the norms. The first criterion for inclusion in the database was institutional: 78 universities were included, covering the vast majority of university academics in Canada. A number of small universities were excluded, due to difficulty building accurate staff lists.

Academic rosters were built by visiting the website for every department at each target institution and recording the names and position titles of all listed faculty. This was supplemented with institutional directories, and in some cases, by telephoning departments. Faculty members were included in a department if they were listed on that department's website at the time of collection (Summer 2011). The faculty list at this stage was designed to be as inclusive as possible, and to include all current faculty at each institution.

Because the HiBAR database is concerned primarily with staff that have an active role in both teaching and academic research at their institution, this list of faculty was then filtered to include only those faculty who could be reasonably assumed to have both a research and teaching role. Specifically, full time faculty were included, while sessional instructors, emeriti, instructors, clinical professors, and other staff were excluded.

When the position title was ambiguous, the faculty were *included.* For example, some position titles, such as "research chair" do not necessarily require a teaching role (researchers listed only as 'research chair' were included). Furthermore, a small number of institutions provide a list of teaching faculty but do not provide specific position titles. In most cases, these ambiguities were resolved by referring to additional sources or contacting the department in question. Overall, position titles were found for 87.4% of the names in the database, and non-ambiguous position titles were found for 72.7% of the names in the database (14.7% listed position titles that were ambiguous).

Included positions:

- Professors
- Assistant professors
- Lecturers*
- Instructors*
- Deans/associate deans
- Chairs/associate chairs
- Research chairs

Excluded positions:

- Administrative assistants
- Sessional lecturers
- Post doctorates
- Emeriti
- Adjunct professors
- Graduate students
- Visiting professors

*While this term is used at some institutions to describe academic faculty at an early stage of their career (and who were therefore included) at a small number of departments, lecturers and instructors have a teaching role but no research role. This was common in programs with a practicum or applied component, where these staff were technicians, laboratory assistants, or industry professionals. In these instances, lecturers and instructors were excluded.

The second set of criteria for inclusion was disciplinary. Non-academic disciplines (i.e., those that deliver programs of a primarily vocational nature, and which are mainly located in the newer universities in British Columbia) were excluded. So, too, was medicine due to the difficulty in distinguishing between academic and clinical faculty. Applied medical disciplines (such as kinesiology, veterinary medicine, and nursing) were included whenever enough information was available to separate them from medical faculties. Apart from those eliminated by these criteria, all academic staff at target institutions were included

Additional notes:

- Senior administrators were included only if they were listed as faculty on departmental websites.
- If a faculty member was cross-posted (i.e., listed on two separate websites, but not listed as an adjunct in either), they were listed as a faculty in *both* departments.
- When conflicting position title information was encountered, the information listed on the departmental website was assumed to be correct.
- Note that the HiBAR database tends to include slightly more faculty than are reported by statistics Canada (~4.5%).

Step 2: Results assessment

Each name in the database was then used as a search term in Google Scholar to generate a list of publications written by the author in question. The resulting list of publications was then added to a staging database in order to facilitate the process of manually reviewing publication data. This was functionally equivalent to searching for the author's name in the "author" field of Google Scholar's advanced search function and recording the results.

Manual review is necessary because automated data collection processes produce false positives. This is due to a limited ability of software to distinguish between different authors sharing the same name, and sometimes working in the same discipline. Authors with very common names can have bibliometric scores that are inflated as publications by similarly-named authors are falsely attributed. Furthermore, some publications appear more than once in Google Scholar's list of results, duplicating their citation counts or splitting citations for a single paper between two entries. For some types of searches, these problems can cause serious issues for automated data collection process.

Google Scholar results were manually reviewed by HESA staff, to ensure that:

1. The search term used accurately reflects the name used by the researcher in his or her publications. If a difference was found, the search term was corrected. If necessary, Boolean logic was used to include alternate spellings.
2. Publications written by similarly named researchers are excluded. Publications written by other authors were excluded from the database.
3. The articles, books and other publications included are only counted once. All duplicates were combined, maintaining an accurate total of unique citations.

4. Only desired publication types are included. This includes peer-reviewed articles, conference proceedings, books, and scholarly articles from non-peer reviewed sources. It excludes non-scholarly publications such a news articles and patents.
5. A valid number of results were returned. A very small number of researchers (<100) had names that were so common that the search returned 1000 publications (the maximum that Google Scholar will return), each with at least one citation. In these cases, it is possible that core publications (those that affect an individual's H-index) were not returned in the results. In these cases, the search terms were modified in order to narrow the results, but if this failed to reduce the number of results, these individuals were excluded from the database. Less than 100 scholars nation-wide were excluded for this reason.
6. The scholar in question was correctly assessed by the filter criteria in Step 1. If not, the entry was flagged and excluded from the database.

While a manual assessment methodology does not eliminate all errors, it dramatically reduces their incidence. Most importantly, by eliminating cases of high over-attribution, it increases the accuracy of this tool when used to compare groups of researchers.

Additional notes:

- HESA staff used a variety of resources to assess and remove false positives, including CVs, descriptions of research and publication lists on departmental websites, and the personal websites of researchers.

Step 3: Assigning a discipline classification

In order to normalize by discipline, the HiBAR database needed to identify the discipline in which each individual worked. Each entry was manually reviewed in order to assign a discipline code to each faculty. These codes identify both the trunk discipline, and the specific sub discipline of each researcher. A total of six disciplines and 112 sub-disciplines were identified. Interdisciplinary researchers and cross-appointed staff could be assigned multiple discipline codes. HESA staff manually reviewed the publication record, department of employment, and stated research objectives (if available) in order to choose the most appropriate discipline classifications.

Step 4: Error testing and standard score calculation

Next, results were spot-tested by senior staff to test for errors, and were analysed in aggregate to ensure that bias was not introduced into the process by the methodology. Specific sources of bias that were tested include: which staff member performed the analysis, the error detection and data exclusion processes, and the month in which data was collected (as the data collection and analysis process was distributed over six months). Where errors were identified in a batch of entries, data was purged and the data collection and assessment processes were repeated. Systemic bias was not detected. After error testing, data is moved from the staging database to the analysis database.

Finally, a standardized score was calculated for each individual. Average H-indexes can vary enormously from one discipline to another even within a broad field of study like "Science." Math/stats and environmental science both have average H-indexes below seven, while in astronomy and astrophysics, the average is over 20. Simply counting and averaging professorial H-indexes at each institution would unduly favour those institutions that have a concentration in disciplines with more active publication cultures.

The HiBAR database controls for differences in publication disciplines by calculating "standardized H-index scores." These are derived simply by dividing every individual's H-index score by the average for the sub-discipline discipline in which they are classified. Thus, someone with an H-index of 10 in a discipline where the average H-index is 10 would have a standardized score of 1.0, whereas someone with the same score in a discipline with an average of five would have a standard score of 2.0. This permits more effective comparisons across diverse groups of scholars because it allows them to be scored on a common scale while at the same time taking their respective disciplinary cultures into account.

These were then used to calculate averages of standard scores for each group of researchers analyzed in the report. The average standard scored reported at the institutional level (or any other group of scholars) averages the standard scores of researchers at that institution, effectively creating a weighted average that accounts for disciplinary differences within the group.

For example, the group of scholars below is first given a standard score that normalizes their H-index, and then that standard score is averaged to find the group score.

	H-index	Average H-index of scholar's discipline	Standard score	Standard score (Group average)
Scholar 1	5	5	1	
Scholar 2	8	4	2	**2**
Scholar 3	3	1	3	

With this calculation, the average score across an entire discipline will always be one. A scholar who scores above one has a higher H-index than the average of other researchers in the same discipline. A group of scholars with an average above one either has higher-scoring scholars, more scholars with above-average scores, or both.

Additional notes:

- Scholars who were excluded for any of the reasons above were excluded from both the numerator and denominator in all calculations

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