

A rational, successive *g*-index applied to economics departments in Ireland

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Abstract

A rational, successive *g*-index is proposed, and applied to economics departments in Ireland. The successive *g*-index has greater discriminatory power than the successive *h*-index, and the rational index performs better still. The rational, successive *g*-index is also more robust to differences in department size.

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1. Introduction

The *h*-index for individuals (Hirsch, 2005) has taken the world of research assessment by storm. Prathap (2006) and Schubert (2007) independently propose a successive *h*-index for departments. Ruane and Tol (in press) define rational (successive) *h*-indices, which increase the discriminatory power of the original *h*-index, a natural number. The main shortcoming of the *h*-index, however, is that it ignores the number of citations in excess of *h*. Egghe (2006) therefore introduced the *g*-index: like the *h*-index, the *g*-index only counts papers of a minimum quality. A higher *g*-index means more and better papers. Unlike the *h*-index, the *g*-index also increases with the number of citations over the threshold. Here, I take the logical next steps and propose a successive *g*-index, and a rational *g*-index.

The *g*-index is used to rank individuals, while the successive *g*-index is used to rank departments. The successive *g*-index thus complements the successive *h*-index just as the *g*-index complements the *h*-index. The (successive) *g*-index is a natural number. It has the problem that a large fraction of researchers (departments) have the same score. The rational (successive) *g*-index breaks these ties, without changing the overall ranking—exactly as the rational (successive) *h*-index refines the (successive) *h*-index.

I test this to economics departments in the Republic of Ireland. There is nothing particularly interesting about economics in Ireland. However, the number of people is small, which allows for quality control on data and experimentation with new, yet-to-be-automated indices. Irish economists are also a diverse lot, with some world-class researchers and a number of less excellent people. Quality also varies markedly between institutions. See Ruane and Tol (2007) for a more in-depth study of economics in Ireland. The current paper is methodological in nature. The data are used for illustration. Unfortunately, there are no large databases on the *g*-indices of

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individual researchers yet, so any analysis of successive g -indices has to painstakingly collect individual data first.

Section 2 presents data and methods. Section 3 discusses the results. Section 4 concludes.

2. Data and methods

Economists in Ireland were initially identified from the web-sites of the economics departments, and omissions were corrected through a rather vigorous review process driven by a word-of-mouth campaign in this small and close-knit community. Some 200 people were considered, but only 133 of them have published and are associated with one of the nine institutions.

Data were taken from *Google Scholar*, using the *Publish or Perish* add-on developed by Harzing (2007). *Google Scholar* produces higher publication and citation numbers per researcher (cf. Kousha & Thelwall, 2007), and hence higher h - and g -indices than do the *Web of Science* and *Scopus*. However, Ruane and Tol (2007) show that rankings based this database have a high rank correlation with rankings based on the *Web of Science* or *Scopus*, at least for Irish economists. Pauly and Stergiou (2005) show that this is true in general. The main advantage of *Publish or Perish @ Google Scholar* is that it computes the g -index—it is rather elaborate to do this using data from the other databases. Note that the g -index as used here includes self-citations.

The h -index of an individual solves

$$\max_h \sum_{i=1}^h c_i \geq h \quad (1)$$

where c_i is a series of publications, denoted by their number of citations, in declining order. The easiest way to compute the h -index is to rank papers by the number of citations; find the point where rank number and citation number cross; and round down.¹ That is, a researcher has an h -index of h if h is the highest number for which holds that she has h publications that are cited at least h times. Papers that meet the condition $c_i > h$ are said to be in the h -core.

The g -index solves

$$\max_g \sum_{i=1}^g c_i \geq g^2 \Leftrightarrow \max_g \frac{1}{g} \sum_{i=1}^g c_i \geq g \quad (2)$$

Eq. (1) has two equivalent definitions. The formulation on the right is the g -index as proposed by Egghe (2006), but the formulation on the left is perhaps more intuitive. That is, a researcher has a g -index of g if g is the highest number for which holds that she has g publications that are cited at least g times on average. The underlined part is the difference with the h -index. Papers that meet the condition $c_i > g^2$ are said to be in the g -core.

The left-most formulation in (2) is very similar to the A -index as proposed by Jin (2006). However, the A -index is the average number of citations in the h -core, whereas the g -index is the average number of citations in the g -core. As fewer papers are in the h -core and papers are ranked, $A \geq g$. Jin, Liang, Rousseau, & Egghe (2007) propose the R -index, which is the geometric mean of the h -index and the A -index.

The average h -index of a department equals

$$\bar{h} = \frac{1}{N} \sum_{i=1}^N h^i \quad (3)$$

where h^i is a series of department members, denoted by their h -index, in declining order. N denotes the number of department members. The average g -index of a department is defined analogously.

The successive h_1 index of a department solves

$$\max_{h_1} \sum_{i=1}^{h_1} h^i \geq h_1 \quad (4)$$

¹ Rousseau (2007) does not round down, and hence defines a real h -index.

That is, a department has a successive h_1 -index of h_1 is if h_1 is the highest number for which holds that it has h_1 department members that have a h -number of at least h_1 .

The successive g_1 -index, here introduced, is defined as the solution to

$$\max_{g_1} \sum_{i=1}^{g_1} g^i \geq g_1^2 \Leftrightarrow \max_{g_1} \frac{1}{g_1} \sum_{i=1}^{g_1} g^i \geq g_1 \quad (5)$$

where g^i is a series of researchers in a department, denoted by their g -number. That is, a department has a successive g_1 -index of g_1 is if g_1 is the highest number for which holds that it has g_1 department members that have a g -number of at least g_1 on average.

Ruane and Tol (in press) define the rational, successive h_1^Δ -index as

$$h_1^\Delta = h_1 + 1 - \frac{\sum_{i=1}^{h_1+1} \max(0, h_1 + 1 - h^i)}{2h_1 + 1} \quad (6)$$

The numerator is the distance to the next h_1 -index, and the denominator is the maximum distance. If the actual distance equals the maximum distance, $h_1^\Delta = h_1$. If the actual distance approaches zero, $h_1^\Delta \uparrow h_1 + 1$.

The rational, successive g_1^Δ -index is defined as

$$g_1^\Delta = g_1 + \frac{\sum_{i=1}^{g_1+1} g^i - g_1^2}{(g_1 + 1)^2 - g_1^2} \quad (7)$$

As the numbers on the right-hand side are all natural, g_1^Δ is a rational number. We have that

$$g_1 \leq g_1^\Delta < g_1 + 1 \quad (8)$$

for

$$\left(g = 0 \Leftrightarrow \sum_{i=1}^{g_1+1} r_i = g_1^2 \right) \Rightarrow g_1^\Delta = g_1 \quad (9)$$

and, by definition,

$$\sum_{i=1}^{g_1+1} r_i < (g_1 + 1)^2 \quad (10)$$

The g_1 -index equals the g_1^Δ -index rounded down. Like the h_1^Δ -index, the g_1^Δ -index interpolates between g_1 and $g_1 + 1$.²

Rankings based on the g_1 -index produce many ties. The g_1^Δ -index breaks these ties, without affecting the overall ranking.

Using (10), a rational g -index can be defined too, and a successive, rational g_1 -index readily follows. Ruane and Tol (2007) show that the rational, successive h -index and the successive, rational h -index are numerically close—but the latter requires more data collection. The same would hold for the g -index, as the natural g -index equals the rational g -indices rounded down.

3. Results

Table 1 shows the results for the nine institutions in economics in Ireland. Table A.1 in Appendix A shows the scores for the individual researchers. Table 2 shows the ranks of the institutions. The h - and g -indices emphasize different aspects, and the ranks differ. TCD scores best on all fronts except the h_1 -index, where it is trumped by UCD. There are many more economists at UCD than at TCD, including a fair number of good ones, but it lacks a real topper. The same thing explains the rank reversals of NUI Galway and NUI Maynooth. The h_1 -index rewards broadness, and discounts exceptional researchers. The g_1 -index does not.

² The real $g_{(1)}$ -index of Rousseau (2007) also interpolates between g_1 and $g_1 + 1$, but the interpolation is independent of the data. The rational g_1^Δ -index interpolates on the basis of citation data.

Table 1

Scores of the nine institutions^a: average number of publication (p), average number of citations (c), average h -index (h), average g -index (g), h_1 -index (h_1), h_1^Δ -index (h_1^Δ), g_1 -index (g_1), and g_1^Δ -index (g_1^Δ)

	p	c	h	g	h_1	h_1^Δ	g_1	g_1^Δ
CBI	10.7	47.6	3.2	4.9	4	4.67	6	6.46
DCU	10.7	23.3	2.4	3.2	3	3.71	5	5.00
ESRI	49.3	357.3	7.9	12.5	7	7.73	13	13.81
NUIG	25.7	74.7	3.0	5.6	4	4.89	8	8.71
NUIM	18.8	55.0	3.7	5.6	5	5.73	7	7.47
TCD	68.1	436.6	8.1	14.0	7	7.93	16	16.06
UCC	7.1	27.7	2.5	3.8	3	3.86	5	5.64
UCD	46.2	218.7	6.4	11.0	8	8.94	15	15.10
UL	11.9	31.4	2.1	3.2	4	4.67	5	5.27

^a Central Bank and Financial Services Authority of Ireland (CBI), Dublin City University (DCU), Economic and Social Research Institute (ESRI), National University of Ireland Galway (NUIG), National University of Ireland, Maynooth (NUIM), Trinity College Dublin (TCD), University College Cork (UCC), University College Dublin (UCD), University of Limerick (UL).

Table 2

Ranks of the nine institutions^a: average number of publication (p), average number of citations (c), average h -index (h), average g -index (g), h_1 -index (h_1), h_1^Δ -index (h_1^Δ), g_1 -index (g_1), and g_1^Δ -index (g_1^Δ)

	p	c	h	g	h_1	h_1^Δ	g_1	g_1^Δ
CBI	7	6	5	6	5	6	6	6
DCU	8	9	8	8	8	9	7	9
ESRI	2	2	2	2	2	3	3	3
NUIG	4	4	6	4	5	5	4	4
NUIM	5	5	4	5	4	4	5	5
TCD	1	1	1	1	2	2	1	1
UCC	9	8	7	7	8	8	7	7
UCD	3	3	3	3	1	1	2	2
UL	6	7	9	8	5	6	7	8

^a Central Bank and Financial Services Authority of Ireland (CBI), Dublin City University (DCU), Economic and Social Research Institute (ESRI), National University of Ireland Galway (NUIG), National University of Ireland, Maynooth (NUIM), Trinity College Dublin (TCD), University College Cork (UCC), University College Dublin (UCD), University of Limerick (UL).

The h_1 -index has three institutions tied in 5th position, and two in 8th position. The g_1 -index has more discriminatory power: three institutions are tied in 7th place. The h_1^Δ -index breaks some ties, but still has two institutions in joint 6th place. The g_1^Δ -index produces no ties at all. It has the largest discriminatory power.

Table 3 shows the rank correlations between the ranks of Table 2. The different measures largely agree on which institutions are better at research in economics. The average h - and g -index, the h_1 - and g_1 -index, and the h_1^Δ - and g_1^Δ -index have rank correlations of 90% and higher. The alternative g -indices correlate better with the average publication and citation numbers than do the h -indices. This is due to two institutions, large UCD (see above) and small UL, which move around most in the rankings. Because the g -index is an average, it is more robust to differences in size than is the h -index, which is a conditional count.

Table 3

Rank correlations between the rankings of Table 2

	c	h	g	h_1	h_1^Δ	g_1	g_1^Δ
p	0.97	0.82	0.93	0.89	0.91	0.93	0.90
c		0.90	0.98	0.89	0.93	0.94	0.97
h			0.94	0.81	0.84	0.89	0.92
g				0.85	0.88	0.97	0.98
h_1					0.97	0.90	0.86
h_1^Δ						0.92	0.93
g_1							0.96

4. Conclusion

In this paper, I propose a rational, successive g -index for departments. The g -index does not just count papers above a threshold quality, but considers excess quality as well. Therefore, the successive g -index has a greater discriminatory power than the successive h -index. Discriminatory power is further enhanced by redefining the g -index as a rational number. These theoretical expectations are confirmed by an application of economics departments in Ireland. The application also reveals the successive g -index is more robust to difference in department size than is the successive h -index. Applications to other datasets would show the robustness, or lack thereof, of these findings.

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Appendix A

Table A.1
Individual number of publication (p), number of citations (c), h -index, and g -index

		p	c	h	g
Browne, F. X.	CBI	10	164	8	10
Kearns, A.	CBI	11	66	5	8
O'Reilly, G.	CBI	18	67	4	8
McQuinn, K.	CBI	27	68	5	7
Murphy, A. P.	CBI	5	52	2	5
Cassidy, M.	CBI	6	23	3	4
d'Agostino, A.	CBI	15	23	2	4
Gavin, C.	CBI	9	9	2	2
Doran, D.	CBI	5	4	1	1
Birmingham, C.	CBI	1	0	0	0
Gallagher, L. A.	DCU	13	56	5	7
Jacobson, D. S.	DCU	32	77	5	6
Kawakatsu, H.	DCU	16	39	4	6
Largey, A.	DCU	4	20	2	4
Hogan, T.	DCU	10	6	2	2
Poti, V.	DCU	16	8	2	2
McDonnell, T.	DCU	1	1	1	1
McGovern, S.	DCU	4	3	1	1
Tol, R. S. J.	ESRI	240	2594	27	43
Whelan, C. T.	ESRI	114	899	16	26
Ruane, F. P.	ESRI	70	476	13	19
Callan, T.	ESRI	76	469	11	18
Barrett, A.	ESRI	42	335	9	16
FitzGerald, J. D.	ESRI	40	257	9	15
Maitre, B.	ESRI	36	183	7	12
Morgenroth, E. L. W.	ESRI	22	133	5	11
Traistaru-Siedschlag, I.	ESRI	77	157	7	9
Duffy, D.	ESRI	17	55	4	7
Kearney, I.	ESRI	12	39	4	5
Scott, S.	ESRI	8	29	4	5
Whelan, B. J.	ESRI	15	46	4	5
Bergin, A.	ESRI	4	19	2	4
Nolan, A.	ESRI	11	24	3	4
Lyons, S.	ESRI	5	2	2	1
Ahearne, A. G.	NUIG	29	326	5	18
O'Donoghue, C.	NUIG	54	249	9	14
Velupillai, K. V.	NUIG	125	214	6	10

Table A.1 (Continued)

		<i>p</i>	<i>c</i>	<i>h</i>	<i>g</i>
Boylan, T. A.	NUIG	30	85	4	8
McDonough, T.	NUIG	22	78	4	8
O'Shea, E.	NUIG	32	99	6	8
Kennelly, B.	NUIG	10	23	2	6
Keane, M. J.	NUIG	23	26	3	4
Cuddy, M. P.	NUIG	20	10	2	3
Gekker, R.	NUIG	16	6	2	2
van Rensburg, T. M.	NUIG	3	4	1	2
Lally, B.	NUIG	2	1	1	1
Garvey, E.	NUIG	7	0	0	0
Piggins, A.	NUIG	10	0	0	0
Raghavendra, S.	NUIG	3	0	0	0
O'Neill, D.	NUIM	36	253	7	15
Conniffe, D.	NUIM	34	85	6	8
Roche, M. J.	NUIM	50	116	6	8
DeWit, G.	NUIM	18	54	4	7
Sweetman, O.	NUIM	24	68	6	7
Pastine, T.	NUIM	17	50	5	6
Flavin, T. J.	NUIM	14	33	4	5
Doris, A.	NUIM	13	24	2	4
Geary, P. T.	NUIM	8	18	2	4
Hurley, M. J.	NUIM	20	21	3	4
Rousseau, F.	NUIM	7	20	2	4
O'Sullivan, P.	NUIM	3	16	2	3
Pantelidis, T.	NUIM	11	9	2	2
Broome, S. J.	NUIM	8	3	1	1
Lane, P. R.	TCD	161	2515	23	48
O'Rourke, K. H.	TCD	143	1527	19	37
Honohan, P.	TCD	227	1630	21	35
Barry, F. G.	TCD	134	769	13	24
Bradley, J.	TCD	93	644	13	23
O'Hagan, J.	TCD	38	220	9	14
McAleese, D.	TCD	42	201	8	13
Kearney, C.	TCD	85	184	7	12
Matthews, A.	TCD	44	99	5	9
Murphy, A. E.	TCD	74	165	7	9
Barrett, S. D.	TCD	37	82	5	8
Lucey, B. M.	TCD	103	74	4	6
Thijssen, J. J. J.	TCD	26	28	4	6
Drudy, P. J.	TCD	5	26	2	5
Somerville, R. A.	TCD	40	66	5	5
Bristow, J.	TCD	6	23	2	4
Newman, C.	TCD	12	24	2	4
O'Toole, F.	TCD	17	17	3	3
Tamura, Y.	TCD	6	2	1	1
Sjostrom, W.	UCC	17	131	6	11
Doyle, E.	UCC	11	62	6	7
O'Leary, E.	UCC	12	61	5	7
Considine, J.	UCC	9	16	3	4
Kavanagh, C.	UCC	6	14	2	3
Kavanagh, E.	UCC	6	11	1	3
Shinnick, E.	UCC	8	11	2	3
Eakins, J.	UCC	2	6	1	2
McElroy, B.	UCC	2	6	1	2
Kirby, E.	UCC	1	6	1	1
O'Sullivan, N.	UCC	6	5	1	1
Power, B.	UCC	5	3	1	1
Nolan, B.	UCD	201	1220	18	28
Whelan, K. T.	UCD	69	813	14	28

Table A.1 (Continued)

		<i>p</i>	<i>c</i>	<i>h</i>	<i>g</i>
Harmon, C. P.	UCD	72	749	12	26
Leahy, D. M.	UCD	54	421	9	20
Devereux, P. J.	UCD	48	373	8	18
Walsh, B.	UCD	126	498	13	18
Bergin, J.	UCD	58	239	8	16
Kelly, M.	UCD	23	250	8	15
Denny, K.	UCD	71	284	9	14
Kapur, K.	UCD	60	251	9	14
O Grada, C.	UCD	33	190	8	13
Walsh, P. P.	UCD	148	254	9	13
Farrell, L.	UCD	28	152	6	12
Clinch, J. P.	UCD	53	133	6	11
Madden, D.	UCD	36	131	6	10
Bargain, O.	UCD	21	96	5	9
Thom, D. R.	UCD	27	110	7	9
Whelan, C.	UCD	42	118	6	9
Convery, F. J.	UCD	42	90	5	8
Cotter, J.	UCD	63	88	4	8
Harrison, M. J.	UCD	8	228	2	8
Pastine, I.	UCD	19	55	5	7
Reynolds-Feighan, A.	UCD	17	57	4	7
Walsh, F.	UCD	27	61	3	7
Bredin, D.	UCD	30	47	4	5
Di Maria, C.	UCD	11	22	3	4
Ferreira, S.	UCD	12	16	3	4
Hutson, E.	UCD	20	14	2	3
McCarthy, C	UCD	23	23	3	3
Delaney, L.	UCD	20	8	2	2
Parlane, S.	UCD	9	6	2	2
Kelly, A.	UCD	6	1	1	1
Andreosso-O'Callaghan, B.	UL	6	102	6	6
Boyle, G. E.	UL	56	68	3	6
Leddin, A.	UL	12	42	3	6
Deegan, J.	UL	12	36	3	5
Lenihan, H.	UL	20	28	3	5
O'Donell, M.	UL	1	7	1	1

Individuals are ranked according to (1) institution, (2) *g*-index, and (3) name.

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