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CITATION DISTRIBUTION OF PURE MATHEMATICS JOURNALS

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Abstract

Garfield defined the impact factor of a journal as the ratio of the number of citations which this journal receives in the course of a given year to the number of articles published by that journal within the two preceding years.
We chose the field of pure mathematics for an experiment to see how impact factors change when calculated in another way.
We first derive some mathematical formulae on raw data for impact factors. Then we present our results on impact factors for pure mathematics journals when calculated over several years and we study the orderings resulting from these impact factors. We moreover study the relation between mathematics journals and some life sciences journals (with comparable 2-year impact factors).

1 INTRODUCTION

Ever since his first citation studies of scientific journals Garfield has used the 2-year impact factor to order journals according to their importance [3]. This impact factor is defined as the ratio of the number of citations which a journal receives in the course of a given year to the number of articles published by that journal within the two preceding calendar years.
Although the reason for this choice is well-known, (namely that in many fields such as chemistry and life sciences, papers receive the most citations approximately two years after their publication) we do not feel very happy with this choice. Indeed, Garfield [4] also remarked that impact factors for journals in fields where citation of older literature is more common than in others, are likely to increase if calculated over other time intervals.
As the field of pure mathematics is known to us, we have chosen it for an experiment to see how impact factors change when calculated in another way than is customary. Most data we use come for the Journal Citation Reports section of ISI's Science Citation Index.
In the first section we give some simple mathematical results on raw data for impact factors. In the second section we present our results on impact factors for pure mathematics journals, when calculated over several years, and in the third section we study the orderings ("pecking order of journals" [5]) resulting from these impact factors. In the fourth section we study the relation between mathematics journals and some life sciences journals (with comparable 2-year impact factor) and conclude that pure mathematics journals would benefit from the use of 4-year impact factors.

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2. SOME MATHEMATICAL RESULTS ON RAW DATA FOR IMPACT FACTORS AND RELATED MEASURES

Let c(k) be the number of citations that a journal receives in a fixed year to items published k years before; let p(k) be the number of items published in that same journal k years before and let a(k) be the ratio c(k)/p(k).
The impact factor of a journal as defined by Garfield [3] is given by

$$IF = \frac{c(1) + c(2)}{p(1) + p(2)} .$$

In this note we will also consider impact factors defined over other periods. These are denoted IF(n), where

$$IF(n) = \frac{\sum_{k=1}^{n} c(k)}{\sum_{k=1}^{n} p(k)} ; \quad n = 1, 2, 3, \dots$$

As c(k) = a(k).p(k), the IF(n)'s are weighted averages of the a(n)'s. We recognize Garfield's impact factor as IF(2).

If we denote $\sum_{k=1}^{n} p(k)$ by P(n) and P(0) = 0, then the IF(n) satisfy the following linear difference equation :

$$IF(n) - \frac{P(n-1)}{P(n)} . IF(n-1) = \frac{c(n)}{P(n)} , \; n \geq 1$$

where we put IF(0) = 0.

We will also consider the case where the first year is not taken into account (the truncated impact factor) :

$$IF^*(n) = \frac{\sum_{k=2}^{n} c(k)}{\sum_{k=2}^{n} p(k)} \; ; \; n = 2, 3, 4, \ldots$$

If we denote $\sum_{k=2}^{n} p(k)$ by $P^*(n)$ $(n \geq 2)$ with $P^*(1) = 0$, then $IF^*(n)$ satisfies the following linear difference equation :

$$IF^*(n) - \frac{P^*(n-1)}{P^*(n)} \cdot IF^*(n-1) = \frac{c(n)}{P^*(n)}$$

with $IF^*(1) = 0$.

We remark that $IF(n) \leq \sum_{k=1}^{n} a(k)$ and similarly

$$IF^*(n) \leq \sum_{k=2}^{n} a(k),$$ as all terms are positive.

Let $a(i)$ be the first local maximum of the function a : by this we mean that : $\forall$ s, $1 \leq s \leq i$: $a(s) \geq \max \{a(1), \ldots, a(s-1)\}$ and that $a(i) > a(i+1)$. Then we have the following result.

Proposition 1.1

If the function IF attains a maximum, it is for some $n_0 \geq i$.

<u>Proof</u> : We know that

$$\forall \; k,s : 1 \leq k \leq s \leq i : \frac{c(s)}{p(s)} \geq \frac{c(k)}{p(k)} .$$

Hence $c(s).p(k) \geq c(k).p(s)$. In particular, if $n < i$ then

$$\sum_{k=1}^{n} \sum_{s=n+1}^{i} c(s).p(k) \geq \sum_{k=1}^{n} \sum_{s=n+1}^{i} c(k).p(s) .$$

Adding $\sum_{k=1}^{n} \sum_{s=1}^{n} c(s).p(k) = \sum_{s=1}^{n} \sum_{k=1}^{n} c(k).p(s)$ to both sides gives :

$$\sum_{k=1}^{n} \sum_{s=1}^{i} c(s).p(k) \geq \sum_{k=1}^{n} \sum_{s=1}^{i} c(k).p(s)$$

or

$$\frac{\sum_{k=1}^{n} c(k)}{\sum_{k=1}^{n} p(k)} \leqslant \frac{\sum_{s=1}^{i} c(s)}{\sum_{s=1}^{i} p(s)} .$$

Hence, for $n < i$: $IF(n) \leqslant IF(i)$. This shows that if IF attains a maximum it is for some $n_0 \geqslant i$.

Remark that in all practical situations the function IF does attain a maximum, if only by the fact that journals exist for a finite number of years.
Concering the IF*(n) we have the following result.

Proposition 1.2

For every $n \geqslant 2$ we have : $IF^*(n) > IF(n) \Longleftrightarrow IF(n) > a(1)$.

Proof

$$IF^*(n) > IF(n)$$

$$\Longleftrightarrow$$

$$\frac{\sum_{k=2}^{n} c(k)}{\sum_{k=2}^{n} p(k)} > \frac{\sum_{s=1}^{n} c(s)}{\sum_{s=1}^{n} p(s)}$$

$$\Longleftrightarrow$$

$$\sum_{k=2}^{n} \sum_{s=1}^{n} c(k).p(s) > \sum_{k=2}^{n} \sum_{s=1}^{n} c(s).p(k)$$

$$\Longleftrightarrow$$

$$\left(\sum_{k=2}^{n} c(k)\right). p(1) > \left(\sum_{k=2}^{n} p(k)\right) . c(1)$$

$$\Longleftrightarrow$$

$$\left(\sum_{k=1}^{n} c(k)\right) . p(1) > \left(\sum_{k=1}^{n} p(k)\right) . c(1)$$

$$\Longleftrightarrow$$

$$IF(n) > a(1) .$$

Comments

1. If the number of publications is (approximately) the same every year, IF(n) reaches its maximum in or after the year that the journal received the most citations.
2. The function IF(n) does not necessarily attain its maximum at a local maximum for a(k).
3. Usuallly the maximum of IF(n) is attained at the point or just behind the point where a(k) has reached its maximum (and not at or just behind the first local maximum). However, there are exceptions to this, so all what can be said in general is contained in Proposition 1.1.

4. The more years it takes a journal to reach a maximal number of citations per item published, the more the Garfield impact factor is an underestimation of the maximal impact factor.
5. Usually a(1) < IF(n) for several n, so that usually the maximal IF*(n) is greater than the maximal IF(n). In particular, if a(2) is the maximum of the function a, IF*(n) reaches its maximum for IF*(2). This is often the case.

Already in 1976 Garfield [4] wrote '... Furthermore, calculation of impact based on 1972 and 1973 publications is bound to affect the impact of journals in a field like mathematics, where citation of older literature is far more common than in others. Thus the impact of mathematics journals would be higher if calculated on the basis of 1970 and 1971 publications'.
As a practical experiment we have investigated how the 1985 impact factor of journals in pure mathematics is affected when using different time periods. We have also compared these mathematics journals with some life sciences journals. The results of this experiment will be discussed in the next sections. Now we give some results on special cases to illustrate the propositions and comments of this section (see also Table 7 in the Appendix).

1°) ACTA MATH-DJURSHOLM : 1985

n	1	2	3	4	...
a(n)	1.471	<u>2.286</u>	2.278	1.636	...
IF(n)	1.471	1.839	<u>2.000</u>	1.887	...

The maximal IF occurs 1 year after max (a(n)), which happens to be the first local maximum.

2°) ADV MATH : 1985

n	1	2	3	4	5	...
a(n)	0.600	1.105	1.137	<u>1.630</u>	1.250	...
IF(n)	0.600	0.846	...			...

	7	8	9
a(n)	<u>2.041</u>	1.767	1.092
IF(n)	1.256	<u>1.317</u>	1.283

Here the maximal IF occurs also 1 year after max(a(n)) but this is not the first local maximum.

3°) ANN SCI ECOLE NORM S : 1985

n	1	2	3	4	5	6	...
a(n)	<u>0.350</u>	0.083	0.095	<u>0.625</u>	0.421	0.063	...
IF(n)	<u>0.350</u>	0.205	0.169	0.292	0.315	0.282	...

Here a(1) is the first local maximum; IF(n) attains its maximal value at n = 1, not at n = 4 where a(n) attains its maximum.
The results of this section were announced in [10].

2 IMPACT FACTORS CALCULATED OVER SEVERAL YEARS

As explained in the introduction we have calculated 1984 and 1985 impact factors for journals in pure mathematics. The results for the 1985 impact factors are given in the Appendix (Table 7).
The average 1985-impact factor of these 43 mathematics journals calculated over 2 years is 0.525 and the average impact factor calculated over 4 years is 0.601. We use a z-test to see whether the difference of these two impact factors differs significantly from zero. We obtain :

$$z = \frac{0.601 - 0.525}{S/\sqrt{42}} = 4.55$$

$$\text{with } S^2 = (1/43) \sum_{i=1}^{43} ((IF(4)_i - IF(2)_i) - 0.076)^2 = 0.0117.$$

For this z-value the null-hypothesis (same average impact factor) is not accepted (not even at the 1% level), hence we conclude that it makes a difference to consider 2- or 4-year impact factors. The results we have found for the 1984 impact factors (z = 3.02) corrobate these findings.
Another way to study the differences between impact factors calculated over different time periods is to compare IF(n) with IF(2) (for individual journals). For the sake of this argument we will say that IF(n) differs significantly from the Garfield impact factor, IF(2), if

$$IF(n) \notin \left[IF(2) - \frac{\sqrt{c(1) + c(2)}}{p(1) + p(2)},\ IF(2) + \frac{\sqrt{c(1) + c(2)}}{p(1) + p(2)}\right]$$

(cf. [7]). The results are given in Table 1.

Table 1 : Comparison of IF(n) with IF(2) (1985 data)

n	significant increase for IF(n) w.r.t. IF(2)	significant decrease for IF(n) w.r.t. IF(2)
3	13 times	0 times
4	19 times	0 times
5	17 times	2 times
6	18 times	4 times

The main result is that, on the average, pure mathematics journals have the highest impact factor when calculated over a 4 year period. This would yield a significant increase for 19 out of the 43 journals (i.e. for 44 %) while none of them would suffer a significant decrease.
Considering now all mathematics journals as one large unit, its 2-year impact factor for 1985 is 0.483 and its 4-year impact factor is 0.529. The exact numbers for this macro-mathematics journal are given in Table 2 and illustrated in Fig. 1. The curve in Fig. 1 is only indicative, no curve fitting method was used.

Table 2 : The macro-mathematics journal, where $A(n) = \frac{\sum_{i=1}^{43} c_i(n)}{\sum_{i=1}^{43} p_i(n)}$

n	1	2	3	4	5	6	7	8	9
A(n)	0.371	0.595	0.580	0.572	0.515	0.452	0.432	0.389	0.355
IF	0.371	0.483	0.515	0.529	0.526	0.514	0.502	0.487	0.470

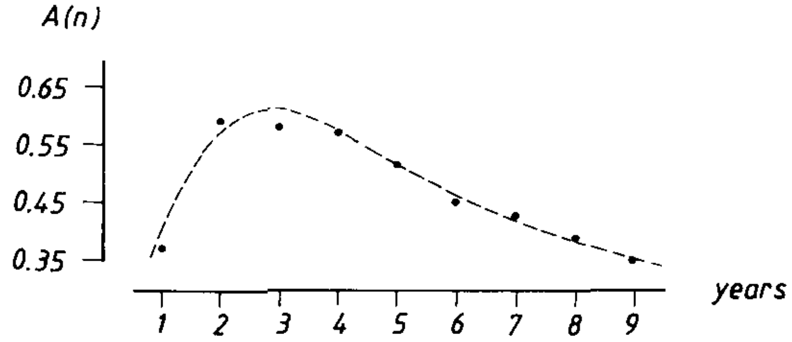

Fig. 1

Comparing this with the average impact factors suggests that journals that publish many papers every year have a relatively low impact factor and journals that publish less papers have a relatively high impact factor. This was observed already many times before as journals that publish many review (hence longer, hence less) papers tend to have larger impact factors than others (see f.i. [8] or [12], p. 258). However, mathematics journals devoted mainly to review papers do not exist. So, the average length of the paper might be a major factor in explaining this phenomenon. Perhaps, one could say that the law of diminishing returns is at work here.

We have checked this by comparing 1985 4-year impact factors of the 10 journals that publish the most, with those of the 10 journals that publish the least (based on 1984 publication data) (see Table 3).

To test whether the averages are the same we use Aucamp's variation of the z-test [1], as we have no information on the ratio of variances (this is a so-called Behrens-Fischer problem). Using the notation of [1] we find here :

$\hat{C} = 0.0572$; $v = 2.1614$; $N = 1.095$; hence
$z = v/N = 1.97 > 1.65$.

So we reject the null hypothesis that these averages are equal (1-sided test; 5 % level).

Table 3.

Journal	# publications	IF(4)
P AM MATH SOC	396	0.283
T AM MATH SOC	257	0.718
J ALGEBRA	195	0.504
PAC J MATH	194	0.359
DISCRETE MATH	174	0.303
MATH Z	145	0.488
COMMUN ALGEBRA	142	0.346
MATH ANN	128	0.658
J LONDON MATH SOC	115	0.383
MATH PROC CAMBRIDGE	112	0.388
AVERAGE		0.443
STANDARD DEVIATION		0.140
ACTA MATH-DJURSHOLM	17	1.887
ANN SCI ECOLE NORM S	20	0.292
B SCI MATH	25	0.305
MEM AM MATH SOC	29	0.738
MATHEMATIKA	34	0.367
MICH MATH J	35	0.446
COMMENT MATH HELV	35	0.604
TOPOLOGY	38	0.806
ANN MATH	38	1.846
ADV MATH	40	1.137
AVERAGE		0.843
STANDARD DEVIATION		0.568

3 ORDERINGS BASED ON 2-YEAR AND 4-YEAR IMPACT FACTORS

Table 4 gives the orderings of the pure mathematics journals according to their 2- and 4-year impact factors in 1985. The Spearman rank correlation coefficient for these orderings is 0.907 which is very significant ($t(41) = 13.8$). The corresponding orderings for 1984 yield a Spearman rank correlation coefficient of 0.893, which again is very signficant ($t(41) = 12.7$).

Further, the Spearman rank correlation coefficient between the orderings based on these two 2-years impact factors is 0.891 and is 0.912 for the orderings based on the 4-year impact factors; both results are very significant. It seems however that, at least for mathematics journals, the orderings based on the 4-year impact factor seem more stable over the years than those based on the 2-year impact factor. Of course, this needs further verfication.

Now, it would be rather awkward if we found no correlation between orderings based on impact factors, or between orderings based on impact factors in two consecutive years. Indeed, we try to find orderings based on the same notion (impact), but measured by different, yet very related means. Hence if those different approaches would lead to uncorrelated orderings this would indicate that there was something wrong with the quantity we try to measure.

However, in view of possible applications of such lists (f.i. acquisitions or relegations in libraries) it is interesting to observe that, although total orderings are highly correlated, this is not the case for those journals with lowest impact factors. Table 5 shows that in 1985 there was no correlation between ordered lists of the pure mathematics journals with lowest 2-year impact factors and the

Table 4. Journals in pure mathematics ordered bij 2- and 4-year impact factor (1985).

2-year impact factor			4-year impact factor		
1	ACTA MATH-DJURSHOLM	1.839	1	ACTA MATH-DJURSHOLM	1.887
2	ANN MATH	1.390	2	ANN MATH	1.846
3	INVENT MATH	1.251	3	B AM MATH SOC	1.311
4	DUKE MATH J	1.039	-	INVENT MATH	1.311
5	B AM MATH SOC	0.963	5	ADV MATH	1.137
6	ADV MATH	0.846	6	J FUNCT ANAL	1.019
7	J FUNCT ANAL	0.807	7	DUKE MATH J	0.985
8	T AM MATH SOC	0.733	8	TOPOLOGY	0.806
9	P LONDON MATH SOC	0.676	9	AM J MATH	0.789
10	INDIANA U MATH J	0.673	10	P LONDON MATH SOC	0.755
11	AM J MATH	0.634	11	MEM AM MATH SOC	0.738
12	COMPOS MATH	0.627	12	T AM MATH SOC	0.718
13	J DIFFER EQUATIONS	0.623	13	J DIFFER EQUATIONS	0.665
14	TOPOLOGY	0.618	14	INDIANA U MATH J	0.662
15	MEM AM MATH SOC	0.609	15	MATH ANN	0.658
16	MATH ANN	0.589	16	COMPOS MATH	0.617
17	J ALGEBRA	0.497	17	COMMENT MATH HELV	0.604
18	COMMENT MATH HELV	0.486	18	B SOC MATH FR	0.509
19	MATH Z	0.437	19	J ALGEBRA	0.504
20	MATHEMATIKA	0.418	20	MATH Z	0.488
21	ISRAEL J MATH	0.414	21	ISRAEL J MATH	0.459
22	J LONDON MATH SOC	0.401	22	J COMB THEORY A	0.452
23	MATH PROC CAMBRIDGE	0.374	23	MICH MATH J	0.446
24	J COMB THEORY A	0.364	24	MANUSCRIPTA MATH	0.444
25	PAC J MATH	0.363	25	MATH PROC CAMBRIDGE	0.388
26	MANUSCRIPTA MATH	0.353	26	J LONDON MATH SOC	0.383
27	MICH MATH J	0.347	27	MATHEMATIKA	0.367
28	AM MATH MON	0.339	28	PAC J MATH	0.359
29	COMMUN ALGEBRA	0.337	29	Q J MATH	0.353
30	P K NED AKAD A MATH	0.320	30	COMMUN ALGEBRA	0.346
31	DISCRETE MATH	0.313	31	STUD MATH	0.330
32	NAGOYA MATH	0.302	32	J MATH SOC JPN	0.323
33	MATH SCAND	0.301	33	J NUMBER THEORY	0.310
34	B SCI MATH	0.275	34	B SCI MATH	0.305
35	J MATH SOC JPN	0.274	35	DISCRETE MATH	0.303
-	P AM MATH SOC	0.274	-	MATH SCAND	0.303
37	B SOC MATH FR	0.257	37	AM MATH MON	0.295
38	J NUMBER THEORY	0.250	38	CAN J MATH	0.294
-	Q J MATH	0.250	39	ANN SCI ECOLE NORM S	0.292
40	ANN SCI ECOLE NORM S	0.205	40	NAGOYA MATH J	0.285
41	MATH USSR SB	0.187	41	P AM MATH SOC	0.283
42	CAN J MATH	0.159	42	P K NED AKAD A MATH	0.262
43	STUD MATH	0.156	43	MATH USSR SB	0.244

$\sum_i \Delta_i^2 = 1237$; r_s(Spearman) = 0.907; $t(41) = 13.8$

Table 5. Ordering of those mathematics journals with lowest 2-year impact factor (1985)

2-year impact factor		4-year impact factor	
1	COMMUN ALGEBRA	1	B SOC MATH FR
2	P K NED AKAD A MATH	2	Q J MATH
3	DISCRETE MATH	3	COMMUN ALG
4	NAGOYA MATH J	4	STUD MATH
5	MATH SCAND	5	J MATH SOC JPN
6	B SCI MATH	6	J NUMBER THEORY
7	J MATH SOC JPN	7	B SCI MATH
-	P AM MATH SOC	8	DISCRETE MATH
9	B SOC MATH FR	-	MATH SCAND
10	J NUMBER THEORY	10	CAN J MATH
-	Q J MATH	11	ANN SCI ECOLE NORM S
12	ANN SCI ECOLE NORM S	12	NAGOYA MATH J
13	MATH USSR SB	13	P AM MATH SOC
14	CAN J MATH	14	P K NED AKAD A MATH
15	STUD MATH	15	MATH USSR SB

$$\sum_i \Delta_i^2 = 590.5; \quad r_s \text{ (Spearman)} = -0.05; \quad t(13) = -0.18$$

list consisting of the same journals ordered according to their 4-year impact factors. For the 1984 data the Spearman rank correlation coefficient is 0.43 which is not significant on the 5 % level (t(13) = 1.72).
As such we do not agree with Tomer [12] who considers the impact factor to be an uninformative derivation of the uncorrected rates of citation, which fails to furnish genuinely useful insight or guidance in regard to the relative quality of scientific journals.

4 A COMPARISON BETWEEN MATHEMATICS JOURNALS AND LIFE SCIENCES JOURNALS WITH APPROXIMATELY THE SAME 2-YEAR IMPACT FACTOR

For every pure mathematics journal we have chosen a life sciences journal in such a way that their 1985 Garfield impact factors differ at most one standard deviation as calculated in [7]. Table 6 gives the mathematics journals and their companion life sciences journals.
After we had chosen these life sciences journals we have tested the hypothesis that the probability that the mathematics 2-year impact factor exceeds the corresponding life sciences' is greater than or equal to 1/2.

We find (using the method of [2]) :

$$\frac{|0.5 - 0.36| - \frac{1}{86}}{\sqrt{\frac{(0.5)(0.5)}{43}}} = 1.68 \approx t(42).$$

Table 6. Math journals and comparable life science journals
A : 2-year impact factor (1985)
B : 4-year impact factor (1985)

	A	B		A	B
ACTA MATH-DJURSHOLM	1.839	1.887	MOL CELL BIOCHEM	2.059	2.595
ADV MATH	0.846	1.137	CANCER BIOCHEM BIOPH	0.860	0.859
AM J MATH	0.634	0.789	ANAL LETT PT B	0.572	0.708
AM MATH MON	0.339	0.295	AM J PHARM EDUC	0.313	0.338
ANN MATH	1.390	1.846	INT J BIOL MACROMOL	1.359	1.135
ANN SCI ECOLE NORM S	0.205	0.292	ACTA MICROBIOL HUNG	0.260	0.314
B AM MATH SOC	0.963	1.311	ARCH INT PHYSIOL BIO	0.965	1.066
B SCI MATH	0.275	0.305	ZH MIKROB EPID IMMUN	0.280	0.328
B SOC MATH FR	0.257	0.509	MICROBIOLOGY	0.265	0.311
CAN J MATH	0.159	0.294	ANN PHARM FR	0.173	0.208
COMMENT MATH HELV	0.486	0.604	B MOL BIOL MED	0.486	0.458
COMMUN ALGEBRA	0.337	0.346	MICROBIOLOGICA	0.311	0.466
COMPOS MATH	0.627	0.617	CURR MED RES OPIN	0.596	0.630
DISCRETE MATH	0.313	0.305	AM J PHARM EDUC	0.313	0.338
DUKE MATH J	1.039	0.985	EXP MYCOL	1.023	1.078
INDIANA U MATH J	0.637	0.662	Z ALLG MIKROBIOL	0.692	0.625
INVENT MATH	1.251	1.311	INT J BIOL MACROMOL	1.359	1.135
ISRAEL J MATH	0.414	0.459	REV FR TRANSFUS IMMU	0.417	0.405
J ALGEBRA	0.497	0.504	J IMMUNOPHARMACOL	0.510	0.705
J COMB THEORY A	0.364	0.452	Z MIKROSK ANAT FORSC	0.403	0.395
J DIFFER EQUATIONS	0.623	0.665	SEIKAGAKU	0.645	0.443
J FUNCT ANAL	0.807	1.019	PHARM WEEKBLAD	0.807	0.804
J LONDON MATH SOC	0.401	0.383	DEV IND MICROBIOL	0.418	0.460
J MATH SOC JPN	0.274	0.323	FOLIA MICROBIOL	0.280	0.305
J NUMBER THEORY	0.250	0.310	ACTA MICROBIOL HUNG	0.260	0.314
MANUSCRIPTA MATH	0.353	0.444	VOP VIRUSOL	0.382	0.389
MATH ANN	0.589	0.658	ANAL LETT PT B	0.572	0.708
MATH PROC CAMBRIDGE	0.374	0.388	INDIAN J BIOCHEM BIO	0.381	0.394
MATH SCAND	0.301	0.303	FARMAKOL TOKSIKOL	0.275	0.274
MATH USSR SB	0.187	0.244	ARCH IMMUNOL THER EX	0.220	0.231
MATH Z	0.437	0.488	FLUORIDE	0.431	0.443
MATHEMATIKA	0.418	0.367	PEDIATR PHARMACOL	0.419	0.588
MEM AM MATH SOC	0.609	0.738	CURR MED RES OPIN	0.596	0.630
MICH MATH J	0.347	0.446	INDIAN J BIOCHEM BIO	0.381	0.394
NAGOYA MATH J	0.302	0.285	UKR BIOKHIM ZH	0.300	0.302
P AM MATH SOC	0.274	0.283	PHARMACOPEIAL FORUM	0.268	0.265
P K NED AKAD A MATH	0.320	0.262	AN QUIM C-ORG BIOQ	0.289	0.281
P LONDON MATH SOC	0.676	0.755	ITAL J BIOCHEM	0.750	0.664
PAC J MATH	0.363	0.359	VOP VIRUSOL	0.382	0.389
Q J MATH	0.250	0.353	KHIM PHARM FR	0.230	0.231
STUD MATH	0.156	0.330	ANN PHARM FR	0.173	0.208
T AM MATH SOC	0.733	0.718	ITAL J BIOCHEM	0.750	0.664
TOPOLOGY	0.618	0.806	SEIKAGAKU	0.645	0.443

A one-sided test on the 10 % level rejects the null hypothesis. Hence we conclude that these life sciences journals have a greater 2-year impact factor than their corresponding pure mathematics journals. However, for the 4-year impact factor we can not reject the hypothesis that the probability to be the greater of the two is 1/2 for both. (We note that in absolute numbers life sciences journals have the larger 2-year impact factor in 27.5 times out of 43 (being equal counts for 1/2 time), and that mathematics journals have the larger 4-year impact factor 25 times out of 43.)

Remark however that also for this selected group of life sciences journals, the average 2-year impact factor (= 0.470) is smaller than the average 4-year impact factor (= 0.512). We conjecture that in general 4-year impact factors are larger than 2-year impact factors and intend to investigate this in the near future.

5 FINAL REMARKS AND CONCLUSIONS

We have also studied maximal impact factors, truncated impact factors and impact factors calculated over different 2-year periods. These results learn us nothing new. Moreover, we think there is no rationale to prefer the last two measures to the first two. (For those interested, we refer to our full report [11]).

We propose the 4-year impact factors as a better measure for medium term impact and conjecture it to be more stable over the years than Garfield's impact factor. On the other hand, the maximal impact factor might yield a measure which is more comparable across scientific fields.

For further research we suggest, among other possible alternatives, the incorporation of these findings in Price's theory on the immediacy effect (cf [9], [6]).

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APPENDIX

Table 7. Impact factors IF(n) for mathematics journals (1985).

Journals	1	2	3	4	5	6	7	8	9
ACTA MATH-DJURSHOLM	1.471	1.839	2.000	1.887	1.750	1.704	1.641	1.764	1.750
ADV MATH	0.600	0.846	0.961	1.137	1.161	1.114	1.256	1.317	1.283
AM J MATH	0.559	0.634	0.616	0.789	0.802	0.750	0.777	0.748	0.754
AM MATH MON	0.267	0.339	0.307	0.295	0.270	0.239	0.226	0.223	0.211
ANN MATH	1.289	1.390	1.739	1.846	1.928	1.904	1.846	1.774	1.804
ANN SCI ECOLE NORM S	0.350	0.205	0.169	0.292	0.315	0.282	0.243	0.247	0.228
B AM MATH SOC	0.696	0.963	1.337	1.311	1.175	1.160	1.225	1.103	0.850
B SCI MATH	0.200	0.275	0.278	0.305	0.310	0.314	0.300	0.277	0.260
B SOC MATH FR	0.114	0.257	0.394	0.509	0.454	0.438	0.449	0.439	0.407
CAN J MATH	0.078	0.159	0.227	0.294	0.354	0.375	0.351	0.344	0.337
COMMENT MATH HELV	0.429	0.486	0.523	0.604	0.559	0.551	0.518	0.528	0.503
COMMUN ALGEBRA	0.289	0.337	0.360	0.346	0.344	0.342	0.320	0.328	0.321
COMPOS MATH	0.615	0.627	0.567	0.617	0.598	0.605	0.578	0.560	0.561
DISCRETE MATH	0.241	0.313	0.299	0.303	0.315	0.311	0.302	0.298	0.301
DUKE MATH J	0.717	1.039	1.026	0.985	1.083	1.129	1.104	1.084	0.991
INDIANA U MATH J	0.429	0.673	0.696	0.662	0.671	0.648	0.613	0.602	0.568
INVENT MATH	0.929	1.251	1.291	1.311	1.371	1.347	1.311	1.305	1.329
ISRAEL J MATH	0.362	0.414	0.388	0.459	0.452	0.465	0.467	0.475	0.471
J ALGEBRA	0.410	0.497	0.502	0.504	0.507	0.487	0.472	0.448	0.423
J COMB THEORY A	0.183	0.364	0.399	0.452	0.409	0.380	0.395	0.372	0.368
J DIFFER EQUATIONS	0.413	0.623	0.640	0.665	0.663	0.668	0.651	0.627	0.615
J FUNCT ANAL	0.588	0.807	0.892	1.019	0.961	0.934	0.929	0.905	0.894
J LONDON MATH SOC	0.148	0.401	0.408	0.383	0.364	0.344	0.319	0.290	0.267
J MATH SOC JPN	0.170	0.274	0.268	0.323	0.318	0.317	0.335	0.342	0.346
J NUMBER THEORY	0.217	0.250	0.309	0.310	0.316	0.318	0.322	0.316	0.297
MANUSCRIPTA MATH	0.318	0.353	0.400	0.444	0.448	0.439	0.416	0.386	0.372
MATH ANN	0.383	0.589	0.677	0.658	0.646	0.605	0.580	0.568	0.560
MATH PROC CAMBRIDGE	0.321	0.374	0.381	0.388	0.387	0.396	0.383	0.370	0.378
MATH SCAND	0.191	0.301	0.317	0.303	0.358	0.343	0.322	0.339	0.335
MATH USSR SB	0.125	0.187	0.221	0.244	0.271	0.255	0.258	0.253	0.265
MATH Z	0.366	0.437	0.481	0.488	0.481	0.454	0.428	0.412	0.403
MATHEMATIKA	0.265	0.418	0.410	0.367	0.386	0.365	0.350	0.342	0.331
MEM AM MATH SOC	0.586	0.609	0.667	0.738	0.761	0.981	0.901	0.871	0.904
MICH MATH J	0.171	0.347	0.463	0.446	0.412	0.384	0.383	0.369	0.332
NAGOYA MATH J	0.196	0.302	0.291	0.285	0.265	0.256	0.252	0.256	0.272
P AM MATH SOC	0.222	0.274	0.280	0.283	0.275	0.272	0.266	0.254	0.240
P K NED AKAD A MATH	0.224	0.320	0.299	0.262	0.243	0.232	0.220	0.211	0.191
P LONDON MATH SOC	0.364	0.676	0.699	0.755	0.755	0.764	0.780	0.710	0.684
PAC J MATH	0.314	0.363	0.362	0.359	0.357	0.333	0.313	0.306	0.290
Q J MATH	0.262	0.250	0.323	0.353	0.333	0.320	0.300	0.294	0.302
STUD MATH	0.098	0.156	0.312	0.330	0.340	0.330	0.369	0.355	0.382
T AM MATH SOC	0.685	0.733	0.728	0.718	0.705	0.691	0.658	0.626	0.597
TOPOLOGY	0.626	0.618	0.731	0.806	0.856	0.810	0.797	0.760	0.739
AVERAGE	0.404	0.525	0.573	0.601	0.598	0.590	0.580	0.567	0.552
Number of journals that attain their maximal IF	1	7	7	7	9	6	2	2	2