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RATIO OF SHORT TERM AND LONG TERM IMPACT FACTORS AND SIMILARITIES OF CHEMISTRY JOURNALS REPRESENTED BY REFERENCES

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Some important bibliometric characteristics of chemistry journals were studied. Contrary to expectations, calculations of impact factors asynchronized for shorter and longer periods yield similar values. A new overlap measure for journals is suggested which is based on frequency distribution of references by journals.

Introduction

For characterization of the international role of journals in science "impact factors", IF (i.e., mean citedness of papers) are widely used. The IF-values can be calculated with time-windows synchronized or asynchronized depending on the synchronity of time-periods selected for publication and citation (*Vinkler*, 1996). Indicators synchronized may characterize the permanent impact of journals within the period selected whereas indices asynchronized refer to the actual impact of journals in the year referencing.

Selection of appropriate citation and publication time-windows is crucial for calculating impact factors. Impact factors standardized and generalized for journals have been introduced by *Garfield* (1979) and refer to a single year referencing and two years referenced. In practice, there is often necessary to know longer term impacts, as well. Impact factors synchronized for five years (a period of five years referencing and referenced) were used by *Schubert* et al. (1989). The present author applied impact factors of 10 years asynchronized (one year for referencing and 10 years for a period referenced) for evaluating papers of research teams (*Vinkler*, 1998). The idea that relations of documents referencing/referenced represent thematical relationships, was applied for determining relatedness of journals, e.g., by *Price* (1965) and *Xhingnesse*

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and *Osgood* (1967). In the present work two overlap measures for sets consisting of journals based on frequencies of references are introduced, namely Percentage and Proportional Overlaps.

Results and discussion

Short term and long term impact factors

55 Chemistry (11 organic, 11 physical, 10 general, 3 analytical, 6 polymer, 7 structural and spectroscopic and 7 biochemical) journals listed in SCI JCR were selected in order to study bibliometric characteristics and ratio of impact factors with different time-windows. Table 1 shows data calculated for journals representing organic chemistry. Time periods and source of data used for calculating impact factors are given in Table 2.

Table 1
Some bibliometric data and indicators for representative organic chemistry journals (1995)

Journal	Impact factor			Total no. of references	Journals preferably referenced		Impact factors of journals referenced		RRS*
	h_{2a}	h_{5a}	h_{10a}	in 1995	No.	citations obtained in per cent	mean (h_{ref})	weighted mean (h_{wref})	
J. Org. Chem.	3.251	2.944	2.348	51287	6	50.29	3.759	3.760	1.157
Synlett	2.447	2.235	2.056	10480	5	50.24	3.980	3.637	1.498
Tetrah. Letters	2.257	2.004	1.776	39544	6	52.36	3.759	3.517	1.558
Tetrahedron	2.147	1.988	1.835	34826	7	50.01	3.456	3.421	1.593
Synthesis S.	2.031	1.802	1.510	8432	8	50.95	3.295	3.420	1.684
J. Organomet. Ch.	1.645	1.240	1.213	22593	7	52.75	3.450	3.383	2.057
J. Chem. S. Perkin T.	1.641	1.736	1.219	12371	8	50.51	3.278	3.189	1.943
Heterocycles	0.916	0.858	0.725	7219	11	50.09	2.143	2.563	2.799
Synth. Comm.	0.703	0.704	0.608	6664	7	50.72	2.615	2.829	4.024
J. Het. Chem.	0.615	0.588	0.493	5460	13	50.00	2.559	2.667	4.337
Org. Prep. Proc. I.	0.609	0.737	0.567	2536	12	50.24	2.816	3.040	4.992

Legends
Weighting is made by numbers of references
h_{2a}: impact factor asynchronized(Garfield Impact Factor)
h_{5a}; h_{10a}: impact factors referring to 5 and 10 publication years, resp.
* Relative Reference Strategy, RRS = h_{wref}/h_{2a}

Table 2
Synchronized (h_s) and asynchronized (h_a) period impact factors calculated with different time windows

Impact factor	Year(s) referencing	Years referenced	Source
h_{2a}	1995	1993-1994	SCI Journal Citation Reports
h_{5a}	1995	1990-1994	present work
h_{10a}	1995	1985-1994	present work
h_{5s}	1981-1985	1981-1985	Schubert et al. (1989)

Legends
h_{na}: impact factors asynchronized(n = 2, 5, 10, resp.)
h_{5s}: impact factor synchronized for five years

The data in Tables 1, 3 reveal that contrary to our expectations, impact factors of two and five years (h_{2a}, h_{5a}, respectively) asynchronized show similar values. The long term impact factor (h_{10a}) is lower only of about 10 per cent compared to h_{2a}. The above statements are in agreement with our earlier findings (*Vinkler* 1988). The value of the indicator synchronized (h_{5s}) is, however, significantly higher than any asynchronized, in agreement with our expectations.

Table 3
Basic statistical data of the indicators for the 55 chemistry journals studied

Indicator	Mean	SD	SEM	95 % Confidence interval	
h_{2a}	2.488	2.245	0.305	1.875	3.101
h_{5s}	4.154	2.894	0.393	3.364	4.943
h_{5a}	2.494	2.492	0.339	1.814	3.174
h_{10a}	2.156	2.316	0.315	1.524	2.788
RRS	1.888	0.977	0.133	1.621	2.155
h_{ref}	3.285	1.923	0.261	2.760	3.809
h_{wref}	3.489	1.729	0.235	3.017	3.961

Legends
$h_{na,s}$: impact factor asynchronized or synchronized for *n* years

$$\text{RRS: Relative Reference Strategy} = \frac{\text{weighted mean of impact factors of journals referenced}}{\text{impact factor of journal(s) referencing}}$$

h_{ref}, h_{wref}: mean and weighted mean impact factor of journals referenced, resp. (weighted by the number of references)

The agreement between the impact factors with various time-windows is excellent (Table 4). This finding supports the view that, in general, short term and long term impact of journals of similar research fields and with similar publication characteristics run parallel.

Table 4
Pearson correlation coefficients for impact factors with different time-windows and Relative Reference Strategy (RRS)

	h_{2a}	h_{5a}	h_{10a}	h_{5s}	RRS
h_{2a}	1.00				
h_{5a}	0.98*	1.00			
h_{10a}	0.97*	0.99*	1.00		
h_{5s}	0.89*	0.88*	0.87*	1.00	
RRS	-0.56*	-0.52*	-0.50*	-0.47**	1.00

Legends
*: significant at $p < 0.0001$ (two tailed)
**: significant at $p = 0.0003$ (two tailed)
For h_{2a}, h_{5a}, h_{10a}, and h_{5s} see Table 2

Relative Reference Strategy

For characterizing the average impact of information sources of authors of journals a specific scientometric indicator, mean impact factor of journals referenced can be used. Applying impact factors (or other impact characteristics) of journals, however, impact of the literature referenced can be compared to that of referencing in order to obtain a relative measure.

The concept of and indicators for characterizing relative reference strategy (RRS) of authors, teams or journals have been introduced several years ago (*Vinkler* 1988). The RRS indicator relates mean (or weighted mean) impact factor of journals referenced (h_{ref}, h_{wref}, resp.) to that of journal(s) referencing (h_{2a}). Only those journals referenced are taken into account in Table 1, 3 and 4 which belong to information pools with similar characteristics as the periodical referencing. Consequently, multidisciplinary journals like *Science* and *Nature* and review journals were omitted. The journals preferably referenced were counted which contained $\geq$ 50 per cent of the total number of references, cumulatively. Investigating data in Tables 1, 3, 4, two main regularities can be realized. First, referencing journals of higher impact factor is preferred (i.e. RRS > 1) second, journals with relatively high impact factor refer to journals of similar high value (i.e. RRS ~ 1). The statements above can be termed as the first and second low of referencing.

Yearly Impact Factors of journals

"Annual impact" of journals for characterizing the actual impact of a set of papers was suggested by *Peterson* (1988). The index mentioned (i.e. impact factor referring to a given year) is equal to the ratio of citations obtained e.g. in 1996 to papers published by a given journal in 1996 or in 1995, in 1994 etc. to the number of papers published in the given year (1996 or 1995, 1994 etc., resp.).

Relative strengths of the annual impacts of information were calculated taking the highest Yearly Impact Factor as 100 per cent (YIF; *Vinkler*, 1991). Table 5 presents the percentage YIF data of some journals selected. Table 6 contains means of Percentage Yearly and Relative Yearly Impact Factors (YIF, RYIF, resp.) calculated. Mean YIF for the second year was found to be the highest (92.10%). After 10 years the impact of papers decreases by about 50 per cent. Decrease of YIF indices in time can be described by a function suggested by *Chew* and *Chew* (1988) as follows: $YIF(t) = ae^{-bt}$, where YIF(t) represents the actual impact of papers, *a* and *b* are constants. (Noting that t = 1 means the year when YIF shows maximum.)

Table 5
Change in absolute and percentage values of Yearly Impact Factors (YIF, YIF %, resp.) for some representative periodicals of chemistry

Periodical	Year										
	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985
J. Phys. Chem.	0.573	2.918	3.853	3.515	3.345	3.061	2.591	2.506	2.355	2.127	2.063
YIF %	20.7	82.1	100.0	91.2	86.8	79.4	67.2	65.0	61.1	55.2	53.2
J. Org. Chem.	0.595	3.052	3.442	3.091	2.640	2.450	2.041	1.780	1.670	1.534	1.366
YIF %	17.3	88.7	100.0	89.8	76.7	71.2	59.3	51.7	48.5	44.6	39.7
Macromolecules	0.540	2.742	3.567	3.395	3.006	3.086	2.687	3.183	2.704	2.470	1.983
YIF %	15.1	76.9	100.0	95.2	84.3	86.5	75.3	89.2	75.8	69.2	55.6
Bioorg. Chem.	0.370	0.740	1.540	1.110	1.714	0.900	1.089	1.028	1.090	0.740	0.657
YIF %	21.6	43.2	89.8	64.8	100.0	52.5	63.5	60.0	63.6	43.2	38.3
J. Am. Ch. Soc.	1.019	4.754	5.740	5.653	5.091	4.337	3.820	3.668	3.424	2.906	3.089
YIF %	17.8	82.8	100.0	98.5	88.7	75.6	66.6	63.9	59.7	50.6	53.8

Remark
References in 1995 refer to papers published in the same year or in one of the years, earlier
For YIF % see Table 6

Table 6
Means of Percentage Yearly and Relative Yearly Impact Factors (YIF %, RYIF, resp.) for 55 chemistry journals and descriptive statistical data for YIF %

Year	YIF %	RYIF	SD	SEM	95 % Confidence interval	
0	15.87	0.17	7.05	0.95	13.96	17.77
1	74.17	0.81	16.59	2.23	69.67	78.64
2	92.10	1.00	14.74	1.98	88.11	96.08
3	85.28	0.93	15.55	2.09	81.06	89.47
4	82.10	0.89	15.02	2.02	78.03	86.16
5	74.50	0.81	12.53	1.68	71.11	77.88
6	65.63	0.71	14.88	2.00	61.60	69.64
7	61.17	0.66	14.29	1.92	57.30	65.03
8	56.26	0.61	13.22	1.78	52.68	59.83
9	51.57	0.56	10.16	1.37	48.82	54.32
10	50.12	0.54	17.70	2.45	45.19	55.05

Remarks
SD: standard deviation (YIF %)
SEM: standard error of the mean (YIF %)

$$\text{YIF \%} = 100\,\frac{\text{(number of citations obtained in 1995 to papers published in a single year selected)}}{\text{(number of papers published in the year selected)}}$$

References given in 1995 to papers published in the same year (0) or one, two etc. years earlier
Relative Yearly Impact Factor for the i-th year: $(\text{RYIF})_i = (\text{YIF \%})_i \,/\, (\text{YIF \%})_{max}$

Predicting impact factors of different time windows

From the means of Relative Yearly Impact Factor data (Table 6) approximate ratios of the impact factors with different time windows can be concluded. Tables 7 and 8 show the method for obtaining mean yearly RYIF data synchronized and asynchronized. Calculating Garfield Impact Factors (h_{2a}) e.g. we apply citations to papers in the first and second year prior to the referencing year (Table 7). Consequently, yearly mean RYIF can be calculated as follows: 0.81 + 1.00 = 1.81; 1.81/2 = 0.905. h_{5a} or h_{10a} can be calculated similarly (Table 7). Table 9 contains ratios of the impact factors for two, five and ten years asynchronized and synchronized, calculated and obtained. The agreement beetween the data is excellent except for the impact factor synchronized (h_{5s}). The agreement between the values of impact factors asynchronized found and calculated, makes it possible to predict the impact factors referring to different time-periods referencing/referenced using data in Tables 6, 7.

Table 7
Examples for calculating means of Relative Yearly Impact Factors asynchronized from data in Table 6

	Referenced years										Referencing year
Rank	10.	9.	8.	7.	6.	5.	4.	3.	2.	1.	0.
Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	0.54	0.56	0.61	0.66	0.71	0.81	0.89	0.93	1.00	0.81	
						0.81	0.89	0.93	1.00	0.81	
									1.00	0.81	

$mh_{10a} = 7.52/10 = 0.752$
$mh_{5a} = 4.44/5 = 0.888$
$mh_{2a} = (1.00 + 0.81)/2 = 0.905$

Table 8
Example for calculating means of Relative Yearly Impact Factors synchronized from data in Table 6

	Referencing years = Referenced years				
Rank	4.	3.	2.	1.	0.
Year	1991	1992	1993	1994	1995
					0.17
				0.17	0.81
			0.17	0.81	1.00
		0.17	0.81	1.00	0.93
	0.17	0.81	1.00	0.93	0.89

$mh_{5s} = 9.84/5 = 1.968$

Table 9
Ratios (h/h) of impact factors with different time windows obtained for the 55 chemistry journals studied. (Values calculated by means of Yearly Impact Factor data are given in brackets)

h	h_{2a}	h_{5a}	h_{10a}	h_{5s}
h_{2a}	1.00			
h_{5a}	1.00	1.00		
	(1.02)			
h_{10a}	1.15	1.16	1.00	
	(1.20)	(1.18)		
h_{5s}	0.60	0.60	0.52	1.00
	(0.46)	(0.45)	(0.38)	

Table 10
Overlap measures for bibliometric sets of journals referencing calculated by frequency of journals referenced

Hooper Overlap
(Hooper, 1965)

$$HO(J) = \frac{\sum_{i=1}^{K}\sum_{j=1}^{J} k_{i,j}}{\sum_{j=1}^{J} J_j}$$

Legends
K: number of common elements
J: number of overlapping sets
$k_{i,j}$: number of the i-th common element in the j-th set
J_j: number of elements in the j-th set

Percentage Overlap
(this work)

$$PO(J) = \frac{\sum_{i=1}^{K}\sum_{j=1}^{J} 100 \cdot p_{i,j}/P_j}{J}$$

Legends
$p_{i,j}$: number of parts in the i-th common element of j-th set
P_j: number of parts in the j-th set

Correlational Overlap
(this work)

$$CO[A,B] = \frac{\left(T\sum_{i=1}^{T} f_{i,A}\, f_{i,B}\right) - 1}{\sqrt{\left[\left(T\sum_{i=1}^{T} f_{i,A}^2\right) - 1\right]\left[\left(T\sum_{i=1}^{T} f_{i,B}^2\right) - 1\right]}}$$

Legends
T: total number of elements calculated
$P_{A,B}$: total number of parts in elements in set [A] and [B], resp.

$$f_{i,A} = \frac{p_{i,A}}{P_A}$$

$P_{i,A}$: number of parts in the i-th element in set [A]

Remark
Elements are journals and parts are numbers or percentage frequencies of references

Overlap of chemistry journals investigated by references

References in a scientific paper are in relation to each other and to the paper referencing, as to their contents. Consequently, it can be supposed that relationship of periodicals can be followed by investigating frequency of their information sources. This idea was proved by *Peters* et al. (1995) by co-citation and co-word analysis.

Thematic relations of some representative organic, physical and chemistry, general journals were investigated by three different overlap measures (Table 10).

The three different overlap measures in Table 10 characterize different aspects of overlaps. Hooper Overlap (HO) (*Hooper*, 1965) relates, namely, the ratio of the number of common elements (i.e. common journals) to the total number of journals in the overlapping sets. Consequently, this measure does not take into account the frequency of parts (i.e. references) in the common elements. Percentage Overlap (PO), introduced here, represents the mean frequency of parts in common elements of the overlapping sets. The measure takes into account all non-zero frequencies of parts in the common elements.

Correlational Overlap (CO), introduced here, compares the frequency distributions of parts in elements belonging to two overlapping bibliometric sets. It calculates with all elements, the only precondition is that the frequency of any part should not be equal to zero simultaneuosly in both sets. The formula for calculating CO values is derived from that of Pearson given for determining product-moment correlation coefficients of two variables.

Number and frequency of references given by the journals representing different chemistry subfields were taken from SCI JCR, 1995. The journals referenced were taken into account which contained ≥ 0.50 per cent of the total number of references given by the respective periodical in 1995.

Table 11 shows bilateral Hooper, Percentage and Correlational Overlap measures for the physical chemistry journals selected, as an example. The overlap measures indicate a close thematical relationship between *J. Catal.* and *J. Mol. Catal.*, whereas *J. Phys. Chem.*, *J. Chem. Phys.*, *Chem. Phys. Lett.*, *Chem. Phys.*, *J. Chem. Soc. Farad. T.* and *Ber. Bunsen Phys. Chem.* represent a different information set. The journals mentioned latter can be assumed as members of the primary information base of physical chemistry.

Table 11
Overlap measures for physical chemistry journals selected and descriptive statistical data

Referencing Referenced	JCC	JCP	JPC	L	JC	SS	CPL	CP	JCSFT	JMC	BBPC
JCC	100.0										
JCP	44.4	100.0									
	75.9										
	56.2*										
JPC	54.9	61.9	100.0								
	83.2	86.3									
	70.3*	74.9*									
L	37.8	41.0	64.0	100.0							
	50.1	63.5	82.2								
	23.8	15.8**	49.7*								
JC	12.2	16.0	39.1	37.6	100.0						
	24.3	16.1	58.1	51.6							
	-4.1	-6.3	9.4	3.3							
SS	20.8	35.8	44.4	42.6	32.6	100.0					
	14.6	44.2	63.8	42.0	26.6						
	-3.1	14.7	8.7	0.4	-1.6						
CPL	56.6	81.0	69.8	40.0	19.6	40.0	100.0				
	73.5	93.1	90.7	62.2	20.0	49.1					
	61.8*	93.9*	83.9*	22.0	-5.6	13.4					
CP	56.0	73.2	68.1	49.0	22.2	31.8	81.0	100.0			
	74.1	89.0	88.8	56.5	16.8	46.2	94.8				
	56.4*	95.3*	78.3*	16.0	-6.2	9.5	94.8*				
JCSFT	32.8	47.8	73.1	63.0	52.0	40.8	51.0	51.0	100.0		
	54.9	77.5	90.8	82.9	52.4	59.1	72.5	65.5			
	49.0*	60.4*	82.5*	48.1*	26.7	11.7	66.0*	61.5*			
JMC	24.6	16.6	37.0	32.2	69.2	15.6	16.4	18.8	44.8	100.0	
	25.9	17.3	45.5	34.0	77.0	24.8	21.2	18.0	51.1		
	12.4	-14.1	14.0	3.3	59.9*	-11.7	-9.3	-13.4	18.8		
BBPC	38.4	55.8	65.3	47.0	25.6	39.2	59.0	62.6	68.0	21.8	100.0
	60.3	79.7	85.7	57.7	42.4	65.8	80.4	82.1	85.3	31.4	
	55.1*	89.7*	82.7*	23.4	-0.6	17.1	89.3*	87.3*	68.3*	-8.7	

Remarks
JCC: *J. Comp. Chem.*, JCP: *J. Chem. Phys.*, JPC: *J. Phys. Chem.*, L: *Langmuir*, JC: *J. Catal.*, SS: *Surf. Sci.*, CPL: *Chem. Phys. L.*, CP: *Chem. Phys.*, JCSFT: *J. Chem. S. Farad. T.*, JMC: *J. Mol. Catal.*, BBPC: *Ber. Bunsen. Phys. Chem.*
Each overlap measures are given in per cent
Hooper Overlap (HO)
Percentage Overlap (PO)
Correlational Overlap (CO)
*: significant at $p < 0.0005$
**: significant at $p < 0.03$

	HO	PO	CO
n	55	55	55
$\bar{x}$	44.40	57.79	37.74
SD	18.36	24.54	32.19

n: number of data
$\bar{x}$: mean
SD: standard deviation

Table 12
Data and indicators characterizing overlap of journals referencing by frequency of references
(The overlap measures are given in per cent)

Data and indicators	Physical Chemistry	Organic Chemistry	Chemistry, General
Number of representative journals referencing	11	11	10
Number of journals preferably referenced	86	63	59
Number of journals referenced by each journals referencing (common elements)	2	8	11
Hooper Overlap			
total set	8.03	29.62	37.31
mean of bilateral overlaps	44.41	73.72	69.57
n	55	55	45
SD	18.36	15.19	9.79
Percentage Overlap			
total set	18.60	62.02	67.30
mean of bilateral overlaps	57.79	76.94	84.43
n	55	55	45
SD	24.54	22.15	6.71
Correlational Overlap			
mean of bilateral overlaps	33.74	73.82	67.36
n	55	55	45
SD	32.19	27.68	16.07
N; N %	12; 21.82	39; 70.91	26; 57.78

Legends
1. Representative journals for organic chemistry and physical chemistry referencing are given in Table 1 and 11, resp.;
2. Journals selected for chemistry, general are as follows: *J. Am. Chem. Soc.*, *Angew. Chem.*, *Liebigs Ann.*, *J. Chem. Soc. Chem. Comm.*, *Helv. Chim. Acta*, *Chem. Ber.*, *Can. J. Chem.*, *B. Chem. Soc. Japan*, *Chem. Lett.*, *Chem. Rev.*
3. Number of journals preferably referenced are those which contain references ≥0.50 per cent of the total in the respective journal. N, N %: number and percentage of journals with CO values higher than 70 %

n: number of bilateral ratios
SD: standard deviation

HO and PO values can be calculated for determining the common overlap of several sets (i.e., journals) taken as a whole system or for obtaining bilaterial ratios of the overlapping journals (*Xhingnesse* and *Osgood*, 1967). Some direct and indirect literature overlap measures were introduced for studying overlaps of information pools of research teams, earlier (*Vinkler*, 1997).

The data in Table 12 show that the overlap measures for the whole set of the representative journals are lower than the means of bilateral values. Correlational Overlap values were calculated for bilateral cases only. The aim of our study was to find measures of similarity characteristic of information contents of journals.The Correlational Overlap indicator is believed to meet this requirement most appropriately because it takes into account not only the quantity or frequency of parts in common elements but the frequency distribution of parts over all elements, as well.

The data in Table 12 show that sets of journals selected for organic chemistrty and chemistry, general represent more coherent information bases than that for physical chemistry.

Conclusions

From the results above conclusions can be drawn as follows:

- short, medium and long term impact factors of chemistry journals run parallel,
- ratio of mean impact factors of journals referenced to the impact factor of the journal referencing yields the Relative Reference Strategy indicator. Authors of chemistry journals prefer referencing journals with high impact factor.
- Pearson correlational coefficients can characterize similarity of journals by contents representing similarity in frequency distribution of references by journals.

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