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SCIENTOMETRIC ANALYSIS OF ATTENDANCE AT INTERNATIONAL SCIENTIFIC MEETINGS

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International scientific meetings represent important channels for communicating research results. Based on data from more than 500 proceedings of scientific meetings, organization and participation patterns of several countries (or geopolitical regions) were analyzed. Some new indicators were derived and proved to be useful in characterizing the scientific activity of the countries. Particularly, the "open" and "closed" nature of national scientific communities, as well as "attraction" and "repulsion" between certain pairs of countries could be revealed by this method.

Introduction

About 90 per cent of the scientific results published in journal articles are previously disseminated in one of the channels of the informal communication domain[1]. Perhaps, the most frequented and favourized channels are lectures at scientific meetings. Namely, before formally publishing them, scientists enjoy speaking in an informal manner to collegues about their results if these results are ready for discussion. On the other hand, an author of a previously published paper rarely reports on it again in the informal domain[2].

The conferences, congresses, symposia, colloquia, or other scientific meetings play an important role in the fast dissemination of research results. However, the formal publication form of the lectures, the proceedings, are published many months or even many years, after the oral presentation[2].

The participants of scientific conferences are going to meetings to communicate and persuade through personal contact, to stimulate innovation and creativity, to obtain recognition or priority and to get current awareness in their broad and/or specialized fields.[3]

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According to *Peters*[3], those scientists who profit most of the participation at scientific meetings, belong to the younger generation, are more specialized, have self perception as deviants and innovators, and perform regular research activities (publishing articles, papers, etc.). Scientists having international experience, having worked or studied abroad, being competently acquainted with languages are the most successfull.

Since scientific conferences are unique channels for the communication of scientific information among individuals, and even between nations[2], their important role is gradually recognized by more and more scientists. Consequently, the annual number of scientific meetings increases steadily; while on a world scale about 5000 scientific meeting were organized in 1958, this number doubled[4] by 1977.

Statistical data on international scientific meetings seem to be suitable for gaining insight into the scientific activity of countries or geopolitical regions. The location, where a meeting has been held, the active or passive participation at these meetings, can be used for characterizing the scientific life of a given country, and, indeed, for building new scientometric indicators.

Aims and scope of the study

We tried to find answer to the following questions: How often were international scientific meetings organized in different countries and in which rate were foreign scientists participating at the conference held there? Do there exist preferred countries visited more frequently by foreign scientists or do there exist countries, whose scientists prefer visiting meetings held abroad? Can the scientific life of a given country, its "open" or "closed" nature be characterized by an organization/participation indicator? Does the activity of a country in scientific meetings correlate with other scientometric indicators?

Source of Data

The Index of Scientific and Technical Proceedings (ISTP) edited by the Institute for Scientific Information[5] was used as our main database. The ISTP contains bibliographical data of about 100000 lectures held at about 3000 meetings per year, that is, nearly the half of the world output of proceedings.

Statistical data for meetings labelled as "International" in their title were compiled from the 1979 annual volume of the ISTP. The main cause of restricting ourselves to international meetings was the apparent overrepresentation of US domestic meetings in our database. By choosing the word "International" in the title as selection criterion, many meetings organized with international participation, but not labelled so were

certainly ommited (e.g. World Congress for. . .); on the other hand there were a scarce number of cases, when so-called "International" meetings had lecturers from a single country, supposedly with an audience of international composition.

The following data were collected: the country where the meetings were held and the number of lecturers from each country. To make a meaningful statistical analysis feasible, the 81 countries in hand were classified into 20 groups (geographical or geopolitical regions). These groups were formed so that the number of published items in each group should not be less than 100. The twenty groups were as follows:

Symbol	Countries
USA	United States of America
UK	United Kingdom and Ireland
D	Federal Republic Germany
F	France and Monaco
SU	Soviet Union
JAP	Japan
CDN	Canada
IND	India
ANZ	Australia, New-Zealand, rest of Asia and Pacific
IL	Izrael
SCA	Scandinavian countries
I	Italy
LAM	Latin-America (incl. Caribic)
EEU	Comecon countries (incl. Yugoslavia)
BNL	Benelux countries
CH	Switzerland and Liechtenstein
A	Austria
SPP	Spain, Portugal, Malta
GTR	Greece, Turkey, Cyprus
AFR	Africa and Near-East (excl. Israel)

The data on "International" meetings referred by the 1979 annual volume of the ISTP are summarized in Table 1. In this table, the number of conference items presented at the meetings held *in* the 20 countries (regions) by scientists coming *from* these countries form a square matrix (transaction matrix). The main diagonal of the matrix shows the number of domestic contributions to the meetings. The total number of items presented at meetings held *in* the single countries and the total number of items

Table 1
Lecturers at international scientific meetings

Country (Number of meetings)	USA	UK	D	F	SU	JAP	CDN	IND	ANZ	IL	SCA	I	LAM	EEU	BNL	CH	A	SPP	GTR	AFR	Total
USA (137)	4026	310	350	288	80	393	253	56	114	57	137	91	65	96	141	83	11	10	2	56	6619
UK (67)	617	988	220	135	48	135	76	32	49	23	107	57	12	97	113	47	19	9	15	36	2835
D (48)	385	152	436	94	44	76	50	9	35	20	65	46	11	70	80	50	26	12	9	16	1686
F (47)	512	233	180	517	42	84	74	7	38	28	107	56	24	74	104	55	9	10	2	12	2168
SU (5)	22	8	17	8	113	16	–	3	–	–	–	1	2	23	4	2	8	3	1	–	231
JAP (27)	306	69	108	65	22	538	33	5	30	9	41	35	8	27	41	22	3	2	3	13	1380
CDN (27)	489	108	50	57	61	78	286	5	20	5	65	13	19	36	47	14	3	2	2	9	1369
IND (6)	159	21	28	24	6	25	12	242	39	4	8	16	9	5	16	5	3	3	3	25	653
ANZ (8)	76	17	12	12	2	12	24	14	103	10	7	2	4	5	–	4	1	—	1	12	318
IL (7)	85	28	18	19	–	9	6	–	6	25	18	5	2	2	11	–	–	–	–	4	238
SCA (23)	259	65	66	49	16	19	66	6	19	11	169	20	7	85	54	22	8	8	2	26	977
I (26)	456	115	80	98	20	25	27	7	13	14	45	202	10	29	53	29	5	3	–	4	1235
LAM (7)	73	10	13	8	1	10	4	1	2	3	8	5	32	5	6	1	1	3	–	1	187
EEU (22)	131	53	75	49	104	23	18	8	4	1	28	19	3	321	27	5	6	–	–	1	876
BNL (33)	363	180	154	103	13	52	55	4	24	11	99	39	10	83	266	29	11	11	6	16	1529
CH (15)	91	51	76	31	5	15	17	–	9	5	29	8	6	12	29	107	9	1	–	10	511
A (13)	96	32	60	15	13	10	15	1	1	5	10	15	1	20	14	8	23	–	–	5	344
SPP (4)	46	24	15	6	–	3	3	1	–	–	7	3	2	8	3	2	1	22	–	1	147
GTR (5)	45	17	43	28	1	19	–	–	4	8	8	6	–	9	14	6	–	1	34	5	248
AFR (5)	40	11	32	10	1	2	4	5	9	4	7	1	6	3	4	1	1	2	2	33	178
Total (532)	8277	2492	2033	1616	592	1544	1023	406	519	243	965	640	233	1010	1027	492	148	102	82	285	23729

authored by scientists coming *from* these countries are indicated at the edge of the rows and columns respectively. On the left end of the rows the total number of meetings examined can be found for each country.

Results and Discussion

Correlation study

Correlations were set up among the number of international meetings organized in the countries (regions) in question, the number of scientists lecturing *in* these countries (the row sums of the matrix in Table 1), the number of the lecturers coming *from* there (the column sums of the matrix), and the number of first authors of journal papers as reported by the 1979 volume of the CBD[6]. The correlation coefficients are presented in Table 2.

The correlation coefficients of Table 2 indicate a strong positive correlation between all of the variables considered. Due to order of magnitude differences between the population of the countries in question, this fact is more or less obvious; the larger the country, the greater the number of scientists, authors, lecturers, hosts or guests.

To uncover more direct relationships between the variables, partial correlation coefficients were calculated as well (Table 3).

Significant partial correlations were found only between the number of first authors of journal papers and the number of lecturers coming *from* the single countries (regions) and between the number of meetings held and the number of scientists lecturing *in* the respective countries. Each country can thus be characterized by two factors: one measuring the extent of scientific contribution – whether in the form of journal articles

Table 2
Correlation coefficients

	Number of first authors	Number of lecturers from	Number of lecturers in	Number of meetings
Number of first authors	1			
Number of lecturers from	0.943	1		
Number of lecturers in	0.767	0.907	1	
Number of meetings	0.733	0.891	0.961	1

Table 3
Partial correlation coefficients

	Number of first authors	Number of lecturers from	Number of lecturers in	Number of meetings
Number of first authors	1			
Number of lecturers from	0.934	1		
Number of lecturers in	− 0.148	0.283	1	
Number of meetings	− 0.441	0.465	0.644	1

or conference lectures – the other representing the propensity for organizing international scientific meetings – equally measurable by the number of conferences held or by the number of participants.

Analysis of the transaction matrix

The matrix presented in Table 1 is a typical example of scientometric transaction matrices studied by *Price* and *Burke*[7,8]. The principle of the following analysis is similar to that of these authors, however, the method of calculation is different.

A single entry, A_{ik}, of the matrix $\underline{\underline{A}}$ represents the number of participants arrived from the k-th country to a meeting held in the i-th country. Our fundamental postulate is that the transaction matrix is the sum of a diadic product matrix and a diagonal matrix:

$$\underline{\underline{A}} = \lambda \underline{a} \square \underline{b} + \underline{\underline{C}}$$

where $\underline{a} = a_i$, $\underline{b} = b_i$ are vectors of unit length, λ is a scalar coefficient, and $\underline{\underline{C}}$ is a diagonal matrix. This postulate says that each country can be characterized by a measure of propensity for organizing international scientific meetings and a measure of participation in such meetings (a_i and b_i – cf. the results of the partial correlation analysis above), moreover, by a measure of surplus contribution in domestic meetings (C_{ii}). A single entry of the matrix can thus be given as

$$A_{ik} = \lambda a_i b_k \quad (i \neq k), \qquad A_{ii} = \lambda a_i b_i + C_{ii}.$$

Vectors $\underline{a}$ and $\underline{b}$ were determined by an iteration method. The iteration was initiated using the row and column sums of the empirical matrix, respectively. Their diadic prod-

Table 4
Participation at international scientific meetings.
Characteristic values of the individual countries

Country	a_i (%)	b_i (%)	$A_{ii} / \lambda a_i b_i$
USA	31.7	22.0	3.35
UK	9.9	11.9	4.86
D	10.1	8.1	3.11
F	7.1	10.3	4.09
SU	2.8	0.7	33.24
JAP	6.2	5.2	9.73
CDN	4.6	6.6	5.50
IND	1.0	2.4	59.75
ANZ	2.5	1.3	19.11
IL	1.3	1.3	9.03
SCA	4.9	4.9	4.09
I	2.7	6.2	7.02
LAM	1.2	0.9	17.30
EEU	4.1	3.4	13.39
BNL	4.8	7.7	4.19
CH	2.3	2.4	11.30
A	0.7	1.9	9.62
SPP	0.5	0.7	37.29
GTR	0.3	1.3	55.74
AFR	1.5	0.9	15.21

uct was multiplied by a scalar coefficient so that the sum of the off-diagonal entries of the resulting matrix should be equal to that of the empirical matrix. The procedure was then repeated using the row and column sums of the matrix obtained in the preceding step until the trace of the matrix remained constant within a given error. The final row and column sums were then normed to unit length to result vectors $\underline{a}$ and $\underline{b}$ respectively; the C_{ii} values were obtained as the differences between the main diagonal entries of the empirical and calculated matrices.

In Table 4 values a_i and b_i as well as ratios $A_{ii}/\lambda a_i b_i$ are summarized for each country (region). Again, the a_i's represent the participation rate of lecturers coming *from*, the b_i's that of scientists lecturing *in* the single countries; the ratio $A_{ii}/\lambda a_i b_i$ indicates the surplus participation in domestic conferences, i.e., the ratio of the number of scientists participating in international conferences held in their home country to their predicted number based on the country's organization and participation rates.

Ratios of observed and predicted values can be calculated for each matrix entry, thereby significant deviations from the postulated simple model can be pointed out. These ratios are the entries of the matrix in Table 5. The main diagonal entries are the values already contained in Table 4; the off-diagonal entries fluctuate around unity,

Table 5
Lecturers at international scientific meetings.
Ratio of observed and calculated values

Country	USA	UK	D	F	SU	JAP	CDN	IND	ANZ	IL	SCA	I	LAM	EEU	BNL	CH	A	SPP	GTR	AFR
USA	3.35	0.82	0.91	1.07	0.75	1.68	1.45	1.51	1.23	1.17	0.74	0.88	1.45	0.61	0.78	0.95	0.39	0.56	0.19	1.00
UK	0.95	4.86	1.06	0.92	0.84	1.07	0.81	1.60	0.98	0.87	1.07	1.03	0.50	1.14	1.15	1.00	1.25	0.94	2.59	1.19
D	0.87	1.10	3.11	0.95	1.13	0.89	0.78	0.66	1.03	1.12	0.96	1.22	0.67	1.22	1.20	1.57	2.53	1.84	2.29	0.78
F	0.91	1.32	1.00	4.09	0.84	0.77	0.91	0.40	0.87	1.23	1.24	1.16	1.15	1.01	1.22	1.35	0.68	1.20	0.40	0.46
SU	0.57	0.66	1.39	0.93	33.24	2.14	0.00	2.52	0.00	0.00	0.00	0.30	1.40	4.57	0.69	0.72	8.89	5.26	2.94	0.00
JAP	1.08	0.78	1.19	1.02	0.88	9.73	0.80	0.57	1.37	0.78	0,94	1.44	0.76	0.73	0.95	1.07	0.45	0.48	1.19	0.98
CDN	1.36	0.96	0.44	0.71	1.92	1.12	5.50	0.45	0.72	0.34	1.18	0.42	1.42	0.77	0.86	0.54	0.36	0.38	0.63	0.54
IND	1.21	0.51	0.67	0.81	0.52	0.98	0.63	59.75	3.84	0.75	0.40	1.42	1.84	0.29	0.80	0.53	0.98	1.55	2.56	4.08
ANZ	1.09	0.78	0.54	0.76	0.32	0.88	2.38	6.51	19.11	3.53	0.65	0.33	1.54	0.55	0.00	0.79	0.61	0.00	1.61	3.69
IL	1.24	1.31	0.83	1.24	0.00	0.68	0.61	0.00	1.14	9.03	1.72	0.85	0.79	0.22	1.06	0.00	0.00	0.00	0.00	1.25
SCA	0.96	0.77	0.77	0.81	0.67	0.36	1.70	0.72	0.91	1.01	4.09	0.87	0.70	2.42	1.33	1.13	1.27	2.01	0.83	2.07
I	1.36	1.09	0.75	1.30	0.67	0.38	0.55	0.68	0.51	1.03	0.87	7.02	0.80	0.66	1.04	1.19	0.64	0.60	0.00	0.26
LAM	1.47	0.64	0.82	0.72	0.23	1.03	0.56	0.65	0.52	1.49	1.05	1.18	17.30	0.77	0.80	0.28	0.86	4.11	0.00	0.43
EEU	0.78	0.92	1.28	1.19	6.41	0.64	0.68	1.42	0.28	0.13	0.99	1.21	0.44	13.39	0.97	0.38	1.40	0.00	0.00	0.12
BNL	0.86	1.37	1.15	1.09	0.35	0.64	0.90	0.31	0.74	0.65	1.53	1.08	0.64	1.51	4.19	0.95	1.12	1.77	1.60	0.82
CH	0.69	1.24	1.82	1.05	0.43	0.59	0.90	0.00	0.89	0.94	1.44	0.71	1.23	0.70	1.46	11.30	2.94	0.75	0.00	1.64
A	0.94	1.00	1.84	0.65	1.43	0.52	1.01	0.32	0.13	1.20	0.64	1.71	0.26	1.49	0.90	1.08	9.62	0.00	0.00	1.05
SPP	1.16	1.93	1.18	0.67	0.00	0.39	0.52	0.81	0.00	0.00	1.15	0.88	1.35	1.54	0.50	0.69	1.08	37.29	0.00	0.54
GTR	0.66	0.80	1.99	1.83	0.17	1.44	0.00	0.00	0.76	2.91	0.77	1.03	0.00	1.01	1.36	1.22	0.00	1.00	55.74	1.58
AFR	0.86	0.75	2.15	0.95	0.24	0.22	0.59	3.47	2.50	2.12	0.98	0.25	3.47	0.44	0.57	0.30	0.92	2.90	4.76	15.21

proving the correctness of our basic postulate. Values significantly higher than unity mean that a country attracts significantly more lecturers from an other one than expected; values lover than unity indicate a "repulsion" effect. In our evaluation values outside the range [0.7, 1.5] were considered significantly different from unity.

Figure 2 illustrates the main conclusions of this kind of analysis. In this figure only those pairs of countries were marked for which both ratios (symmetrical matrix entries) fell outside the above range. Mutually positive and negative as well as unidirectional relations between countries can thus easily be detected. Mutually positive and negative relations mean mutual preference or avoidance of each other's conferences; in case of undirectional relation scientists from one country participate in a higher than expected rate at conferences held in an other country, whereas participation rate in the opposite direction is lower than expected.

Conclusions

According to the correlation study, the strongest positive correlation was found among the number of lecturers travelling to conferences and the number of first authors of journal papers (Fig. 1). *Above* the regression line are countries with high relative

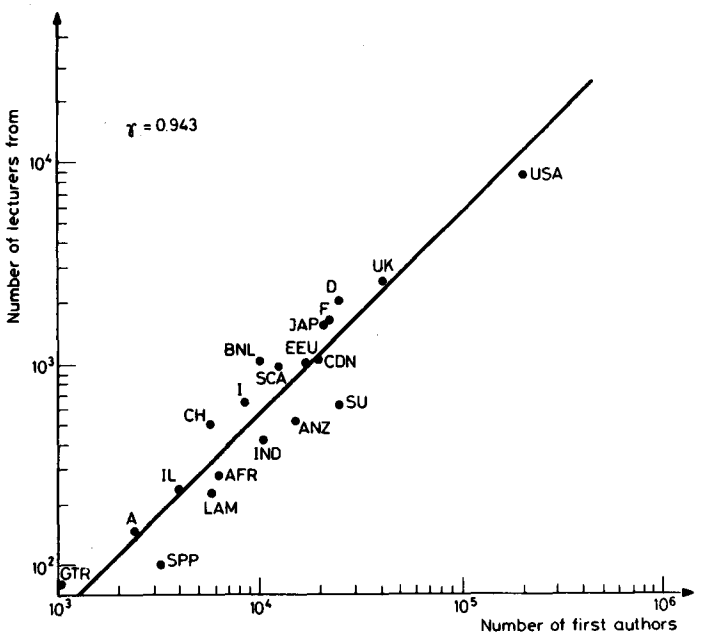

Fig. 1. Correlation between the number of lecturers from the individual countries and the number of first authors of journal papers

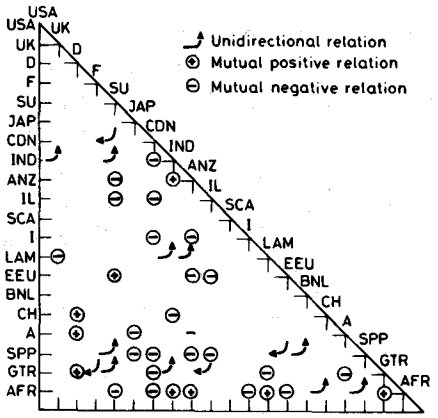

Fig. 2. Relationship between countries as reflected by participation to each other's scientific meetings

participation rate at international scientific meetings while for countries *under* this line the relative participation rate is low. The former group includes the FR Germany, France, Japan, the Benelux countries, the Scandinavian countries, Italy and Switzerland, while the latter comprises the Soviet Union, Australia, India, Africa, Latin-America, Spain and Portugal. The scientific life of countries above the regression line seems to be more open than the average; a similar conclusion can be drawn from other scientometric studies too[9]. The scientific life of countries lying under the line has been characterized by the mentioned analysis also, as having a "more closed" nature and this can be influenced, in some degree, by the geographical distances.

Analyzing the individual relationship between certain countries, on the basis of the data of Figure 2, three groups of countries can be distinguished from which lecturers prefer visiting each other's country. One of these groups includes the FR Germany, Austria, and Switzerland, the other one consists of Africa–Near East, Australia–Pacific–Asia, India, Latin America and Greece–Turkey. The members of the third group are the Soviet Union and the East-European socialist countries (COMECON). In the first case the common language, in the second, common problems (food production) can be the motivation for joint meetings; the relationships between the COMECON countries are well known.

Mutually negative relationships are more frequent; it can be found between the Soviet Union and Australia–Pacific–Asia, Israel and Africa–Middle East as well as between both Canada and India on one side and Israel, Italy, Spain–Portugal and Greece–Turkey on the other. This can be interpreted by geographical and political distances between the countries mentioned.

As to the unidirectional relationships, the asymetrical connection of India and the UK has its origin in the historical past. However, one part of this

kind of relationships has a random character, i.e., a meeting organized in one of these countries, essentially isolated from each other, was attended by a greater delegation from an other country, during the period investigated.

The quotient of a_i and b_i of Table 4 characterises the participation/reception ratio. From these values the conclusion can be drawn that the scientists of the Soviet Union, Australia–Pacific–Asia and Africa–Near East show a strong tendency to traveling abroad; on the other hand, France, India, Italy, the Benelux states, Austria, Greece–Turkey play in general the role of host countries.

Domestic contribution in international meetings ($A_{ii}/\lambda a_i b_i$ values in Table 4) is exceedingly high in India, Greece–Turkey, Spain–Portugal and the Soviet Union; the lowest scores belong to the FR Germany and the USA. It seems that this value is inversely related to the opportunity for lecturing abroad.

Summarizing the results, we can conclude that the distribution of the participants of international scientific meetings depends of the geographical location of the host country, and in addition, the similarity of efforts for scientific development (e.g. in the developing countries), the organizational structure ("open" or "closed" nature) of the scientific communities, the economic situation (traveling expenses can influence the participation rate) and in some cases, political consideration may also have an important role.

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References

1. W. D. GARVEY, *Communication: the Essence of Science,* Facilitating Information Exchange among Librarians, Scientists, Engineers and Students, Pergamon Press, Oxford, New York, etc., 1979.
2. P. R. MILLS, Characteristics of Published Conference Proceedings, *J. Documentation,* 29 (1973) 36.
3. E. B. PETERS, International Scientific and Technical Meetings. Why Go? Who Profits? *R and D Management,* 5 (1975) 139.
4. E. GARFIELD, ISI's New Index to Scientific and Technical Proceedings. Lets You Know, what Went on at a Conference, Even if You Stayed at Home, *Current Contents* No. 40, October 3, 1977.
5. *Index to Scientific and Technical Proceedings (ISTP)* 1979. Philadelphia, Institute for Scientific Information, 1980.
6. Current Bibliographic Directory 1979, Philadelphia, Institute for Scientific Information, 1980.
7. D. de SOLLA PRICE, The Analysis of Square Matrices of Scientometric Transactions, *Scientometrics,* 3 (1981) 55.
8. C. E. BURKE, D. de SOLLA PRICE, The Distribution of Citation from Nation to Nation on a Field by Field Basis. A Computer Calculation of the Parameters, *Scientometrics,* 3 (1981) 363.
9. S. ZSINDELY, A. SCHUBERT, T. BRAUN, Editorial Gatekeeping Patterns in International Science Journals. A New Science Indicator, *Scientometrics,* 4 (1982) 57.