

# **Proceedings of ISSI 2007**

**11<sup>th</sup> International Conference of the International Society for  
Scientometrics and Informetrics**

*Edited by Daniel Torres-Salinas and Henk F. Moed*

# Proceedings of ISSI 2007

11<sup>th</sup> International Conference of the International Society for  
Scientometrics and Informetrics

*CSIC, Madrid, Spain  
25-27 June 2007*

## VOLUME I

### ***Edited by***

#### **» Daniel Torres-Salinas**

- EC<sup>3</sup> Research Group (Evaluación de la Ciencia y la Comunicación Científica)  
Universidad de Granada, Granada, Spain
- Centro de Investigación Médica Aplicada (CIMA)  
Universidad de Navarra, Pamplona, Spain

#### **» Henk F. Moed**

- Centre for Science & Technology Studies (CWTS)  
Leiden University, Leiden, the Netherlands

Published for the International Society for Informetrics and Scientometrics (ISSI) by the Centre for Scientific Information and Documentation (CINDOC) of the Spanish Research Council (CSIC), Madrid, Spain

All rights reserved. No part of this book may be reproduced in any form without the written permission of the authors.

## VOLUME I

## KEYNOTES..... 19

- Eugene Garfield. *From The Science of Science to Scientometrics. Visualizing the History of Science with HistCite Software* ..... 21
- Stevan Harnad. *Open Access Scientometrics and the UK Research Assessment Exercise* ..... 27

## FULL PAPERS AND RESEARCH-IN-PROGRESS PAPERS..... 35

- Rafael Aleixandre-Benavent, Gregorio González-Alcaide, Alberto Miguel-Dasit, Carolina Navarro-Molina and Juan Carlos Valderrama-Zurián. *Full-Text Publications in Peer-Reviewed Journals Derived from Presentations at Two ISSI Conferences* ..... 37
- Éric Archambault and Vincent Larivière. *Origins of Measures of Journal Impact: Historical Contingencies and their Consequences on Current Use* ..... 45
- Judit Bar-Ilan and Bluma C. Peritz. *The Lifespan of “Informetrics” on the Web: an Eight Year Study (1998-2006)* ..... 52
- Franz Barjak and Simon Robinson. *International Collaboration, Mobility and Team Diversity in the Life Sciences: Impact on Research Performance* ..... 63
- Elise Bassecoulard, Alain Lelu, and Michel Zitt. *A Modular Sequence of Retrieval Procedures to Delineate a Scientific Field: from Vocabulary to Citations and Back* ..... 74
- Peter van den Besselaar, Gaston Heimeriks, Koen Frenken. *Variety in Web Spheres between Research Fields: Content and Function* ..... 85
- Sujit Bhattacharya. *Impact of Indian Patents: Assessment through Citation Analysis* ..... 95
- Omwoyo Bosire Onyancha and Dennis N. Ocholla. *Is HIV/AIDS in Africa Distinct? What Can we Learn from an Analysis of the Literature?* ..... 100
- Kevin W. Boyack, Katy Börner and Richard Klavan. *Mapping the Structure and Evolution of Chemistry Research* ..... 112
- Kevin W. Boyack. *Using Detailed Maps of Science to Identify Potential Collaborations* ..... 124
- Robert Braam. *Everything about Genes: some Results on the Dynamics of Genomics Research* ..... 136
- Lutz Bornmann and Hans-Dieter Daniel. *Functional Use of Frequently and Infrequently Cited Articles in Citing Publications. A Content Analysis of Citations to Articles with Low and High Citation Counts* ..... 149
- Jenny-Ann Brodin Danell and Rickard Danell. *Spiritualised Medicine? A Bibliometric Study of Complementary and Alternative Medicine* ..... 154
- Quentin L. Burrell. *Hirsch’s h-index and Egghe’s g-index* ..... 162
- Linda Butler and Kumara Henadeera. *Is there a Role for Novel Citation Measures for the Social Sciences and Humanities in a National Research Assessment Exercise?* ..... 170
- Clara Calero Medina and Ed C.M. Noyons. *Combining Mapping and Citation Network Analysis for a Better Understanding of the Scientific Development: The case of the Absorptive Capacity Field* ..... 179
- Mônica G. Campiteli, Pablo D. Batista and Alexandre S. Martinez. *A Research Productivity Index to Account for Different Scientific Disciplines* ..... 184
- Chaomei Chen, Il-Yeol Song and Weizhong Zhu. *Trends in Conceptual Modeling: Citation Analysis of the ER Conference Papers (1979-2005)* ..... 189
- Chen Li, Pan Yuntao, Ma Zheng, Su Cheng and Wu Yishan. *A Comparative Study between International and Domestic Interdisciplinary Journals and Specialty Journals: A Trial Analysis of Medical Journals, Philosophy Journals and Journals in Philosophy of Medicine* ..... 201
- Heting Chu and Thomas Krichel. *Downloads vs. Citations in Economics: Relationships, Contributing Factors and Beyond* ..... 207
- Mario Coccia. *Does Bureaucracy Affect Research Performance of Public Research Organizations?* ..... 216
- Rodrigo Costas and Maria Bordons. *A Classificatory Scheme for the Analysis of Bibliometric Profiles at the Micro Level* ..... 226
- Viv Cothey. *Applying Egghe’s General Theory of the Evolution of Information Production Processes to the World Wide Web* ..... 231
- S.M. Dhawan and B.M. Gupta. *High Productivity Physics Institutions in India: A Study of their Performance in terms of Quantitative and Qualitative Indicators* ..... 241

Leo Egghe. <i>Distributions of the h-index and the g-index</i> .....	245
Shu Fang, Xian Zhang and Guo-hua Xiao. <i>Research and Application of Patent Map Analysis</i> .....	254
Francisco Fernández-Izquierdo, Adelaida Román-Román, Cruz Rubio-Liniers, Francisco-Javier Moreno- Díaz-del-Campo, Carmen Martín-Moreno, Carlos García-Zorita, Maria Luisa Lascurain-Sánchez, Preiddy-Efraín García, Elisa Povedano and Elías Sanz-Casado. <i>Bibliometric Study of Early Modern History in Spain Based on Bibliographic References in National Scientific Journals and Conference Proceedings</i> .....	266
Enrico Forti, Chiara Franzoni and Maurizio Sobrero. <i>The Effect of Patenting on the Networks and Connections of Academic Scientists</i> .....	272
Chiara Franzoni, Christopher L. Simpkins, Baoli Li and Ashwin Ram. <i>Using Content Analysis to Investigate the Research Paths Chosen by Scientists Over Time</i> .....	285
Rainer Frietsch, Sybille Hinze and Pari Patel. <i>Using Patent Data for Monitoring the Globalisation of R&amp;D</i> .....	295
Antonio García Romero, José Navarrete Cortés, Cristina Escudero, Juan Antonio Fernández López, and Juan Antonio Chaichio Moreno. <i>Measuring the Contribution of Clinical Trials to Bibliometric Indicators: Citations and Journal Impact Factor®</i> .....	300
Monica Gaughan, Branco Ponomariov and Barry Bozeman. <i>Using Quasi-Experimental Design and the Curriculum Vitae to Evaluate Impacts of Earmarked Center Funding on Faculty Productivity, Collaboration, and Grant Activity</i> .....	305
Yves Gingras. <i>Mapping the Changing Centrality of Physicists (1900-1944)</i> .....	314
Wolfgang Glänzel,, Frizo Janssens and Bart Thijs. <i>A Comparative Analysis of Publication Activity and Citation Impact Based on the Core Literature in Bioinformatics</i> .....	321
Isabel Gómez, María Bordons, M.Teresa Fernández, Fernanda Morillo. <i>Structure and Research Performance of Spanish Universities</i> .....	335
Yuri Jack Gómez. <i>Revisiting the "Heroic" Age: From Externalism to Internalism in Serial History of Science</i> .....	346
Iina Hellsten, Renaud Lambiotte, Andrea Scharnhorst and Marcel Ausloss. <i>Self-citation Networks as Traces of Scientific Careers</i> .....	365
Jean-Pierre V. M. Hérubel. <i>Pre 1990 French Doctoral Dissertations in Philosophy: A Bibliometric Profile of a Canonical Discipline</i> .....	368
Kim Holmberg and Mike Thelwall. <i>Local Government Web Sites in Finland: A Geographic and Webometric Analysis</i> .....	378
Peter A. Hook. <i>Visualizing the Topic Space of the United States Supreme Court</i> .....	387
Stefan Hornbostel and Susan Böhmer. <i>Determinants for Young Researcher Careers in Germany. Comparative Evaluation of Postdoctoral Programmes</i> .....	397
Isabel Iribarren-Maestro, María Luisa Lascurain-Sánchez and Elías Sanz-Casado. <i>Are Multi-Authorship and Visibility Related? Study of Ten Research Areas at Carlos III University of Madrid</i> .....	401
Frizo Janssens, Wolfgang Glänzel and Bart De Moor. <i>A Hybrid Mapping of Information Science</i> .....	408
Evaristo Jiménez-Contreras, Rafael Bailón Moreno, Daniel Torres-Salinas, Rosario Ruiz Baños, Rafael Ruiz-Pérez, Mercedes Moneda Corrochano and Emilio Delgado López-Cózar. <i>Response Surface Methodology and its Application in Evaluating Scientific Activity</i> .....	421
Bihui Jin, Ronald Rousseau, Richard P. Suttmeier and Cong Cao. <i>The Role of Ethnic Ties in International Collaboration: The Overseas Chinese Phenomenon</i> .....	427
Richard Klavans and Kevin W. Boyack. <i>Is there a Convergent Structure of Science? A Comparison of Maps using the ISI and Scopus Databases</i> .....	437
Vincent Larivière, Éric Archambault and Yves Gingras. <i>Long-Term Patterns in the Aging of the Scientific Literature, 1900–2004</i> .....	449
Gavin LaRowe, Sumeet Ambre, John Burgoon, Weimao Ke and Katy Börner. <i>The Scholarly Database and Its Utility for Scientometrics Research</i> .....	457
Katarina Larsen. <i>Interdisciplinarity in Environmental Technology Applications – Examining Knowledge Interaction between Physics and Chemistry Research Teams</i> .....	463
Theod N. van Leeuwen and Robert J.W. Tijssen. <i>Strength and Weakness of National Science Systems. A Bibliometric Analysis through Cooperation Patterns</i> .....	469
Jacqueline Leta and Flávio Martins Teixeira. <i>Science in Brazil: Contribution of Male and Female Scientists</i> .....	480
Jonathan Levitt and Mike Thelwall. <i>Atypical Citation Patterns in the Twenty Most Highly Cited Documents in Library and Information Science</i> .....	485
Grant Lewison. <i>The References on UK Cancer Clinical Guidelines</i> .....	489

Loet Leydesdorff and Caroline Wagner. <i>Is the United States Losing Ground in Science? A Global Perspective on the World Science System in 2005</i> .....	499
Liming Liang. <i>Revealed Similarities between the Journals Nature and Science: Using a New Cluster of Rhythm Indicators</i> .....	508
Yuxian Liu and Ronald Rousseau. <i>Hirsch-Type Indices and Library Management: The Case of Tongji University Library</i> .....	514
Ma. Elena Luna-Morales, Francisco Collazo-Reyes and Jane M. Russell. <i>A Quantitative Historiography of Mexican Integration into the International Standards of Scientific Research</i> . ....	523

## VOLUME II

V. Markusova, M. Jansz, I. Libkind and A.Varshavsky. <i>Trends in Russian Research Output in Post-soviet Era</i> .....	542
Elba Mauleón and María Bordons. <i>Women Involvement in Editorial Boards of Mathematics Journals</i> .....	552
Katherine W. McCain. <i>Analysing Influence Over Time: An Historiographic Mapping of the Research of Conrad Hal Waddington (1905-1975)</i> .....	558
Lokman Meho and Kiduk Yang. <i>Fusion Approach to Citation-Based Quality Assessment</i> .....	568
Félix Moya-Anegón, Zaida Chinchilla-Rodríguez, Benjamín Vargas-Quesada, Elena Corera-Álvarez, Antonio Muñoz-Molina, Francisco José Muñoz-Fernández and Rocío Gómez-Crisóstomo. <i>Scientific Output by Gender in Spain (Web of Science, 2004)</i> .....	582
Ahat A. Nabiullin. <i>Emergence of a New Discipline in the Earth Sciences: Bibliometric Analysis of Photogrammetry and Remote Sensing Literature</i> .....	594
Ed C.M. Noyons and Clara Calero-Medina. <i>Applying Bibliometric Mapping in a High Level Science Policy Context. Mapping the Research Areas of Three Dutch Universities of Technology</i> ....	599
José Luis Ortega and Isidro Aguillo. <i>Linear Analysis of Cybermetric Data: Quantifying The European University Web Space</i> .....	608
Xavier Polanco and Eric Sanjuan. <i>Hypergraph Modelling and Graph Clustering Process Applied to Co-word Analysis</i> .....	613
Anastassios Pouris and Anthipi Pouris. <i>The State of Science and Technology in Africa (2000-2004): A Scientometric Assessment</i> .....	619
Ismael Rafols and Martin Meyer. <i>Diversity Measures and Network Centralities as Indicators of Interdisciplinarity: Case Studies in BionanoScience</i> .....	631
Suzy Ramanana-Rahary, Michel Zitt and Ronald Rousseau. <i>Aggregation Properties of Relative Impact and other Classical Indicators: Convexity Issues and the Yule-Simpson Paradox</i> .....	643
I.K. Ravichandra Rao. <i>Distributions of Hirsch-Index and G-index: An Empirical Study</i> .....	655
Victor Rodriguez, Frizo Janssens, Koenraad Debackere and Bart De Moor. <i>On Material Transfer Agreements and Visibility of Researchers in Biotechnology</i> .....	659
Adelaida Román, M <sup>a</sup> -Dolores Alcain and Elea Giménez. <i>Evaluation of Scientific Publications in the Humanities</i> .....	672
Ana Romero-de-Pablos and Joaquín M. Azagra-Caro. <i>Internationalisation of Patents by Public Research Organisations from a Historical and an Economic Perspective</i> .....	677
Ulf Sandström and Martin Hällsten. <i>Gender, Funding Diversity and Quality of Research</i> .....	685
Edgar Schiebel and Marianne Hörlesberger. <i>About the Identification of Technology Specific Keywords in Emerging Technologies: The Case of "Magneto-electronic"</i> .....	691
Jesper Wiborg Schneider, Birger Larsen and Peter Ingwersen. <i>Comparative Study between First and All-Author Co-Citation Analysis Based on Citation Indexes Generated from XML Data</i> .....	696
R. D. Shelton, Patricia Foland, and Roman Gorelsky. <i>Do New SCI Journals Have a Different National Bias?</i> .....	708
Henry Small and Phineas Upham. <i>Citation Structure of an Emerging Research Area: Organic Thin Film Transistors</i> .....	718
Alastair Smith. <i>Issues in "Blogmetrics" - Case Studies Using BlogPulse to Observe Trends in Weblogs</i> .....	726
David Stuart and Mike Thelwall. <i>University-Industry-Government Relationships Manifested Through MSN Reciprocal Links</i> .....	731
Bart Thijs and Wolfgang Glänzel. <i>A Structural Analysis of Benchmarks on Different Bibliometrical Indicators for European Research Institutes Based on their Research Profile</i> .....	736
Robert J.W. Tijssen and Thed. N. van Leeuwen. <i>Research Cooperation within Europe: Bibliometric Views of Geographical Trends and Integration Processes</i> .....	740
Liwen Vaughan and Justin You. <i>Content Assisted Web Co-Link Analysis For Competitive Intelligence</i> .....	745

Peter Vinkler. <i>Introducing the Contemporary Contribution Index for Characterizing the Recent, Relevant Impact of Journals</i> .....	753
Martijn S. Visser, Clara M. Calero Medina and Henk F. Moed. <i>Beyond Rankings: the Role of Large Research Universities in the Global Scientific Communication System</i> .....	761
Liyang Yang, Steven A. Morris and Elizabeth M. Barden. <i>Mapping Institutions and Their Weak Ties in a Research Specialty: A Case Study of Cystic Fibrosis Body Composition Research</i> .....	766
Yang Zhiping, Fang Shu, Cheng Yunwei, Wang Chun, Wen Yi, Hu Zhengyi and Zheng Yi. <i>Profiles of Technological Capabilities of the Chinese Academy of Sciences (CAS). A Comparison of Patenting Activities of the CAS with other National Level Institutions</i> .....	776
Fuyuki Yoshikane, Takayuki Nozawa, Susumu Shibui and Takafumi Suzuki. <i>An Analysis of the Connection between Researchers' Productivity and their Co-authors' Past Attributions, Including the Importance in Collaboration Networks</i> .....	783
Weiping Yue, Yuntao Pan, Zheng Ma and Xishan Wu. <i>A Bibliometric Analysis of siRNA Fundamental Research and Patent Activities</i> .....	792
Michel Zitt,, Elise Bassecoulard, Ghislaine Filliatreau and Suzy Ramanana-Rahary. <i>Revisiting Country and Institution Indicators from Citation Distributions: Profile Performance Measures</i> .....	797
Alesia Zuccala and Peter van den Besselaar. <i>Mapping Review Networks: Exploring Research Community Roles and Contributions</i> .....	803
<b>POSTER PAPERS .....</b>	<b>815</b>
Isidro F. Aguillo, José Luís Ortega and Begoña Granadino. <i>BRIC: Academic Web Contents in the Four Largest Emerging Economies</i> .....	816
Rafael Aleixandre-Benavent, Gregório González-Alcaide, Alberto Miguel-Dasit, Miguel Castellano-Gómez and Juan Carlos Valderrama Zurian. <i>Citation Analysis and Impact Indicators of the Spanish Medical Journals (2001-2005)</i> .....	818
Farzaneh Aminpour and Payam Kabiri. <i>Research Performance in Isfahan University of Medical Sciences: Evaluation of Scientific Productivity</i> .....	820
Farzaneh Aminpour and Payam Kabiri. <i>Webometric Study on Iranian Universities of Medical Sciences</i> .....	822
Emma Angus, Mike Thelwall and David Stuart. <i>University Groups in Flickr: Tagging for Purpose or Pleasure?</i> .....	824
Judit Bar-Ilan. <i>The H-Index of H-Index and of Other Informetric Topics</i> .....	826
Maite Barrios, Angel Borrego, Andreu Vilagines, Marta Somoza and Candela Ollé. <i>Bibliometric Study of Psychological Research on Tourism</i> .....	828
Ana Isabel Bonilla, Tony Hernández and Isabel Gómez. <i>Scientometric Analysis on a Sample of Scientists in Astronomy, Particles Physics and Multidisciplinary Physics in arXiv.org (1996-2006)</i> .....	830
Manfred Bonitz. <i>Spontaneity of Consciousness: V.V. Nalimov's Most Ingenious Book</i> .....	832
R.K. Buter and E.C.M. Noyons. <i>Searching for Converging Research using Citations between Subject Categories: First Results and Challenges</i> .....	834
Rosaria Rosanna Cammarano, Maurella Della Seta. <i>A Review of New Web Tools for Citation Analysis and their Impact on Research</i> .....	836
Carolina Cañibano, Javier Otamendi and Inés Andújar. <i>Exploiting the Potential of Researchers CV Databases for Policy Making: Evidence from the Ramón y Cajal Programme in Spain</i> .....	838
M <sup>a</sup> Angeles Coslado and Juan Miguel Campanario. <i>Contribution to the Impact Factor of Academic Journals in the Field of Education and Educational Psychology of Citations to Articles Authored by Editorial Board Members</i> .....	840
Dang Yaru, Wang Liya, Gao Feng, Li Kan, Huang Yue and He Fenglan. <i>Changes and Development of Key Indicators in JCR on the Web</i> .....	842
Lixin Chen, Zeyuan Liu and Liming Liang. <i>The Relationship of Price Index and Median Citation Age</i> .....	844
Ms. Sandhya Diwakar and Dr. KK Singh. <i>Capacity Building in Specialties towards National Health Research through Research Funding</i> .....	846
Daniela De Filippo, Elias Sanz-Casado and Isabel Gómez. <i>Impact of the Research Stays on the Scientific Output</i> .....	848
E. García-Carpintero, B. Granadino, N. Sastre and L.M. Plaza. <i>The Spanish Presence in Editorial Boards of International Scientific Journals: A Tool for the Promotion of Spanish Science</i> .....	850
Marianne Gauffriau, Peder Olesen Larsen, Isabelle Maye, Anne Roulin-Perriard, Markus von Ins. <i>40 Years Discussion on the Counting of Publications</i> .....	852

Juan Gorraiz, Christian Schlögl. <i>Comparison of two counting houses in the field of pharmacology and pharmacy: Web of Science versus Scopus</i> .....	854
B.M.Gupta, S.M.Dhawan and R. P. Gupta. <i>S&amp;T Research in India: An Overview of its Research Output and Quality</i> .....	856
Yusef Hassan-Montero and Victor Herrero-Solana. <i>Visualizing Library and Information Science from the Practitioner's Perspective</i> .....	858
Frank Havemann, Michael Heinz, Marion Schmidt, and Jochen Gläser. <i>Measuring Diversity of Research in Bibliographic-Coupling Networks</i> .....	860
Juan E. Iglesias and Carlos Pecharromás. <i>Comparing H-indices for Scientists in Different ISI Fields</i> .....	862
Peter Ingwersen, Jesper W. Schneider, Morten Scharff and Birger Larsen. <i>A National Research Profile-Based Immediacy Index and Citation Ratio Indicator for Research Evaluation</i> .....	864
Abdelali Kaaouachi. <i>Institutional Evaluation in Moroccan Higher Educational System: A Proposed Model</i> .....	866
Payam Kabiri and Farzaneh Aminpour. <i>Iranian Medical Research Performance: Does it Comply with the National Needs?</i> .....	868
Hildrun Kretschmer and Theo Kretschmer. <i>Distribution of Co-Author Pairs Frequencies of the Journal of Biological Chemistry Explained as Social Gestalt</i> .....	870
Mojca Kotar. <i>Author Cocitation Analysis of Polyamides Specialty 1974–1999 and the Modification of Multivariate Statistics</i> .....	872
Paula Leite and Jacqueline Leta. <i>Productivity and Prestige among Brazilian Scientists</i> .....	874
Jonathan M. Levitt and Michael Thelwall. <i>Two New Indicators Derived from the h-Index for Comparing Citation Impact: Hirsch Frequencies and the Normalised Hirsch Index</i> .....	876
Grant Lewison. <i>Breast Cancer Research, Death Rates and Life Expectancy in Iceland: Are they Linked?</i> .....	878
Grant Lewison. <i>Counting Citations: Fractionation of Addresses and “World-Scale”, a New Scalar</i> ....	880
Xia Lin. <i>New Visual Interfaces for Author Co-Citation Mapping</i> .....	882
Szu-chia Scarlett Lo. <i>Patent Indicators of Genetic Engineering Research of EU Countries - Overseas Performance: Preliminary Study</i> .....	884
Diana Lucio-Arias. <i>A Validation Study of HistCite™: Using the Discoveries of Fullerenes and Nanotubes</i> .....	886
Renato Fabiano Matheus. <i>Information Science Network – ISN: Social Network Analysis of Scientific Production of LIS Field in Brazil</i> .....	888
Katherine W. McCain. <i>The Relationship between Influence and Image: Two Views of the Oeuvre of Conrad Hal Waddington using Historiographic Mapping and Author Tri-Citation Image Analysis</i> .....	890
Katherine W. McCain and Scot Silverstein. <i>Using Historiographic Mapping to Trace Persistent Highly Visible Research Themes in Medical Informatics</i> .....	892
C.A Macias-Chapula, J.A. Mendoza-Guerrero, I.P Rodea-Castro and A. Gutiérrez-Carrasco. <i>Institutional Health Research Collaboration in Mexico. A Bibliometric Study</i> .....	894
Raúl I. Méndez-Vásquez, Eduard Suñén-Pinyol, Ginés Sanz and Jordi Camí. <i>Characterization of research groups in the cardio-cerebrovascular field. Spain 1996-2004</i> .....	896
Alberto Miguel-Dasit, Gregorio González-Alcaide, Juan Carlos Valderrama-Zurián, Adolfo Alonso-Arroyo and Rafael Alexandre-Benavent. <i>Analysis of the Interdisciplinary Collaboration in Spanish Scientific Production on Radiology and Diagnostic Imaging</i> .....	898
Fernanda Morillo and Daniela de Filippo. <i>The Role of Madrid in the Spanish Regional Collaboration</i> .....	900
Rogério Mugnaini, Elías Sanz-Casado and Carlos García-Zorita. <i>Ways of Adequacy for Evaluation of Brazilian Scientific Production: National Impact versus International Impact</i> .....	902
Rogério Mugnaini, Rogério Meneghini and Abel Packer. <i>Citation Profiles in Brazilian Journals of the SciELO Database in Different Scientific Areas</i> .....	904
Ülle Must. <i>History Research in a Globalized World: a Bibliometric Approach</i> .....	906
Ryosuke L. Ohniwa, Aiko Hibino and Kunio Takeyasu. <i>Perspective Factor: Past, Present and Future of Life Sciences</i> .....	908
José Felipe Ortega, Jesús M. González-Barahona and Gregorio Robles. <i>In-Depth Analysis of Wikipedia Community</i> .....	910
Jose Luis Ortega, Isidro Aguillo, Viv Cothey, Andrea Scharnhorst. <i>Exploring Visually the European Academic Web Space</i> .....	912

Ana Patricia Ortiz, William A. Calo, Carlos A. Suárez, Erik Suárez, Isabel Iribarren and Elías Sanz-Casado. <i>Basic Characteristics of Cancer-related Research in Puerto Rico: An Approach to Local and International Journals</i> .....	914
Pang Jing'an, Wang Lian and Cao Yan. <i>Quantification Evaluation of Technical Innovation Capabilities of Chinese Large and Medium Industrial Enterprises</i> .....	916
K. G. Pillai Sudhier. <i>Ranking Journals in Physics: An Informetric Study of the Citations in the Doctoral Theses of the Indian Institute of Science</i> .....	918
Marios Poulos, Nikolaos Korfiatis and George Bokos. <i>Towards the Construction of a Global Bibliometric Indicator</i> .....	920
Hampus Rabow. <i>A Bibliometric Analysis of Book Based Literature</i> .....	922
Cristina Ramo. <i>Research in Doñana National Park: Preliminary data</i> .....	924
Claude Robert, Concepción S. Wilson, Jean-François Gaudy and Charles-Daniel Arreto. <i>The Evolution of the Sleep Scientific Literature over 30 Years: A Bibliometric Analysis</i> .....	926
Gwendolyn Rogge and Ronald Rousseau. <i>Is the European Web British or American?</i> .....	928
Nadine Rons and Arlette De Bruyn. <i>Quantitative CV-Based Indicators for Research Quality, Validated by Peer Review</i> .....	930
Hervé Rostaing, Nicolas Barts, Valérie Léveillé. <i>Scientific Portfolio Analysis of a Scientific Area by a Competitive Position Approach</i> .....	932
Samile Andréa de Souza Vanz and Renato Fabiano Matheus. <i>Analyzing Grey Literature from Postgraduate Programs in Social Communication in Brazil: Network of Influence and Citation Analysis</i> .....	934
Yuan Sun, Masamitsu Negishi and Loet Leydesdorff. <i>National and International Dimensions of the Triple Helix in Japan: University-Industry-Government and International Co-Authorship Relations</i> .....	936
Dimitar T. Tomov and AbdulKader A. Murad. <i>International Communication Patterns in an Emerging Interdisciplinary Field - Applications of Geographic Information Systems in Public Health</i> .....	938
Ming-yueh Tsay. <i>An Analysis and Comparison of Citation Data between Journals of Physics, Chemistry and Engineering</i> .....	940
Yuen-Hsien Tseng, Yu-I Lin, Chun-Hsien Kuo and Yi-Yang Lee. <i>Verification of Increasing Trend Detection</i> .....	942
Ali Uzun. <i>Recent Trends in Renewable Energy Research: A Bibliometric Perspective</i> .....	944
Thanh-Trung Van and Michel Beigbeder. <i>From Web Citation to Web Co-citation: Discovering Relatedness on the Web</i> .....	946
Sonia Vasconcelos, Martha Sorenson and Jacqueline Leta. <i>English Proficiency: A Potential Science Indicator?</i> .....	948
Jakob Voss. <i>Common Statistics of Heterogeneous Tagging Systems</i> .....	950
Chun-Chieh Wang , Mu-Hsuan Huang and Dar-Zen Chen. <i>Innovative Capacity Evaluation of Main Countries Based on Patent Analysis</i> .....	952
Dietmar Wolfram. <i>Search Characteristics in Different Types of Internet-Based IR Environments: Are They the Same?</i> .....	954
Yasuhiro Yamashita, Sen Ueno, Hiroyuki Tomizawa and Masayuki Kondo. <i>Influence of the International Migration of Researchers on National Publications in Three Fields of Engineering</i> ....	956
Li-li Yang, Dong-hong Fu, Xiao-ping Bai, Wei-gang Fang, Shu-yin Yao. <i>Citation Analysis of the Chinese Journal of Medical Science Management</i> .....	958
Lin Yang Lili Yang and Chengzheng Zhao. <i>Assessment of Traditional Chinese Medicine for Substance-Related Disorders Based on Bibliometric Techniques</i> .....	960
Hairong Yu, Concepción S. Wilson, Mari Davis and Fletcher Cole. <i>Complex Data Modelling for Informetric Research</i> .....	962
Jian Zhang, Weizhong Zhu, Yunan Chen, Michael Vogeley and Chaomei Chen. <i>Analyzing the Impact of Sloan Digital Sky Survey on Astronomical Literature: A Multiple Perspective Approach</i> .....	964
Dangzhi Zhao. <i>Factor Rotation Methods in Author Co-citation Analysis: A Comparison</i> .....	966
M.A. Zulueta, G. García-Gómez, I. Doménech, M. Izquierdo and P. Moscoso. <i>Bibliometry Analysis of the Research on Women and Health</i> .....	968
<b>AUTHOR INDEX</b> .....	<b>971</b>

# Response Surface Methodology and its Application in Evaluating Scientific Activity<sup>1</sup>

Evaristo Jiménez-Contreras<sup>\*</sup>, Rafael Bailón Moreno<sup>\*</sup>, Daniel Torres-Salinas<sup>\*\*</sup>, Rosario Ruiz Baños<sup>\*</sup>, Rafael Ruiz-Pérez<sup>\*</sup>, Mercedes Moneda Corrochano<sup>\*</sup> and Emilio Delgado López-Cózar<sup>\*</sup>

<sup>\*</sup>*evaristo@ugr.es*

Departamento de Biblioteconomía y Documentación, Universidad de Granada, Granada-18071 (Spain)

<sup>\*\*</sup>*torressalinas@gmail.com*

Centro de Investigación Médica Aplicada (CIMA), Universidad de Navarra, Pamplona-31008 (Spain)

## Abstract

The possibilities of the Response Surface Methodology (RSM) has been explored within the ambit of Scientific Activity Analysis. The case of the system “Departments of the Area of Health Sciences of the University of Navarre (Spain)” has been studied in relation to the system “Scientific Community in the Health Sciences”, from the perspective of input/output models (factors/response). It is concluded that the RSM reveals the causal relationships between factors and responses through the construction of polynomial mathematical models. Similarly, quasi-experimental designs are proposed, these permitting scientific activity to be analysed with minimum effort and cost and high accuracy.

## Keywords

evaluation of scientific activity; response surface methodology; experimental design

## Introduction

The analysis of scientific activity focusing on the economic input/output model—especially when dealing with institutions—is classical and almost the foundation of scientific evaluation (Martin & Irvine, 1983). This model implies that the system under study has easily defined borders affected by a set of factors or variables called *inputs* and which represent the resources of the system (funding, researchers, equipment, etc.). This system in turn generates or responds to products resulting from their scientific activity, called *outputs*, such as publications or patents.

The relationships which link inputs with outputs are complex and difficult to describe with elemental mathematical models. Therefore, the need arises for tools that are capable of more complex modelling and that achieve maximum refinement of the role of each variable in the system as well as the of synergetic and/or antagonistic interrelationships between the same variables.

The Response Surface Methodology (RSM) emerged in the 1950s (Box & Wilson 1951; Box & Hunter 1951) within the context of Chemical Engineering in an attempt to construct empirical models able to find useful statistical relationships between all the variables making up an industrial system. This methodology is based on experimental design with the final goal of evaluating optimal functioning of industrial facilities, using minimum experimental effort. Here, the inputs are called factors or variables and the outputs represent the response that generates the system under the causal action of the factors or variables. In recent years it is being applied successfully in other scientific fields such as biology, medicine, and economy. Myers et al. (2004) has exhaustively reviewed the literature in the sense, describing the developments and applications of this methodology. Very recently, RSM has been used even to validate new experimental methods (Jurado et al. 2003)

## Objectives

In this presentation, we seek to explore the possibilities of the Response Surface Methodology within the scope of the analysis of scientific activity.

---

<sup>1</sup> This study is part of a project funded by the initiative of the *Centro de Investigación Médica Aplicada de la Universidad de Navarra*. Color Version of all figures are available from the authors.



Figure 2. System Departments of Health Sciences of the University of Navarra

For this, we shall consider the case of the system “Departments of Health Sciences of the University of Navarra”. The University of Navarra will be represented by a system in which the factors (inputs) are the human resources as well as the economic resources while the response (outputs) are the scientific production (Figure 2)

**Materials and methods**

*Description of the method of the response surfaces*

The designs of the response surface methodology (RSM) are those in which problems are modelled and analysed; in these problems the response of interest is influenced by different variables. The RSM is widely used as an optimisation, development, and improvement technique for processes based on the use of factorial designs—that is, those in which the response variable is measured for all the possible combinations of the levels chosen of the factors or variables. The main effect of a factor is defined as the variation in response caused by a change in the level of the factor considered, when the other ones are kept constant. There is an interaction (dependence) between the variables when the effect of one factor depends on the behaviour of another. The application of the RSM becomes indispensable when, after the significant factors affecting the response have been identified, it is considered necessary to explore the relationship between the factor and dependent variable within the experimental region and not only at the borders. Response surfaces are recommended for these types of factorial designs for their effectiveness and quick execution. This consists of correlating the *k* variables put into action through a second-degree polynomial expression of the following form:

$$y_{obs} = b_0 + \sum_{i=1}^k b_i x_i + \sum_{i=1}^{k-1} \sum_{j=i+1}^k b_{i,j} x_i x_j + \sum_{i=1}^k b_{i,i} x_i^2 + e$$

where  $y_{obs}$  is the dependent variable, and  $x_i$  the factors or variables with which we wish to correlate it. The expression contains a first-degree term that represents a linear relationship considered as the principal, another term in which the variables cross each other to represent the influence of some over others, and finally a second-degree term that refines the previous one and gives maximums and minimums—i.e. optimal values of the dependent variable. The symbols  $b_0, b_i, b_{i,j}$  are constants and  $e$  a term of error or residual between the observed and calculated value. The experimental values are adjusted to the above equation by a polynomial regression and the usual statistics can be used to determine the goodness of the fit.

The SRM implies, apart from the use of a second-degree polynomial model, a very reduced experimental design called Central Composite Design (CCD). The CCD is formulated on the basis of the factorial designs adding the star points and the central point, and three types of different structures can be used (Figure 3).

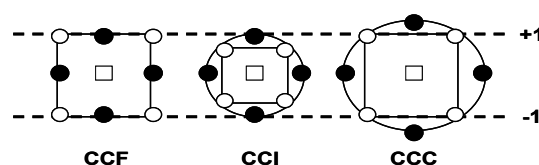


Figure 3. Different structures of CCD: central side (CCF), inscribed (CCI) and circumscribed(CCC)

Regardless of the structure of the composite central design that is used, for each factor or variable, experiments will be performed for 5 different values or levels:  $-\square$ ,  $-1$ ,  $0$ ,  $+1$  y  $+\square$ . Therefore, not all the combinations possible will be made, but rather only those that fulfil a geometric CCD design, i.e. only the points indicated.

In certain applications, the variables cannot take any combination of values, due to certain restrictions. Figure 4 is an example of an experimental window where only in the shaded area, limited by restricting lines, is the design feasible. To facilitate the setting up and fit of the model, a new group of components are defined, these being called pseudocomponents.

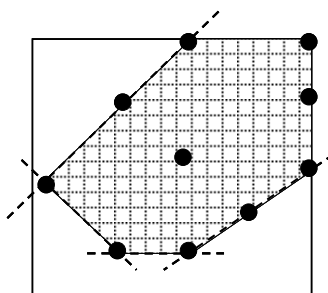


Figure 4. Example of design with restrictions

From the resulting values, for each of the variables, the coefficients of the polynomial equation are determined ( $b_0$ ,  $b_i$ ,  $b_{i,j}$ ) and the equation can be simplified according to the influence of the factors in the final response. The resulting equation is used as a model of a given system to determine the response of  $y$  as a function of the different values of  $x_1$  and  $x_2$  within the defined area in the CCD.

#### **Material: Area of Health Sciences of the University of Navarra**

An evaluation was made of the international scientific production of 50 departments of the University of Navarra (UNAV) related to Biomedicine and Health Sciences in the period 1999-2005. The production data and citations were taken from the Web of Science and those of impact from the Journal Citation Reports corresponding to this period. The information on economic and human resources was provided by the this university. Table 1 presents the variables that have been analysed in this work.

Table 6. Variables analysed in the evaluation of the UNAV

<b>Indicators</b>
<i>N° of researchers</i>
<i>Funding through research projects</i>
<i>N° of works in the databases of Web of Science</i>

Overall, the UNAV produced a total of 2,229 works that have received a total of 19,716 citations. Some 41% of their works have been published in journals in the first quartile. The economic resources identified come from the funding of 534 research projects classified into 5 typologies: Europeans (4%); International (1%); Internal (17%), and Regional (40%). It is assumed that the human resources for the period analysed had an annual mean of 764 full-time researchers, of which 485 were doctors and the rest pre-doctoral students.

#### *Software*

For the calculation of the response surfaces, a specific program was used, Modde v. 4, of the company Umetrics of Sweden ([www.umetrics.com](http://www.umetrics.com))

#### *Results and interpretation of the results*

For the calculation of the response surface of the system “University of Navarra” (UNAV), we used a CCF design with restriction, as shown in Figure 5. The cloud of points represents the group of

departments in the area of Health Sciences of UNAV. The points highlighted are those departments that have the characteristics closest to the CCF type of design with restrictions.

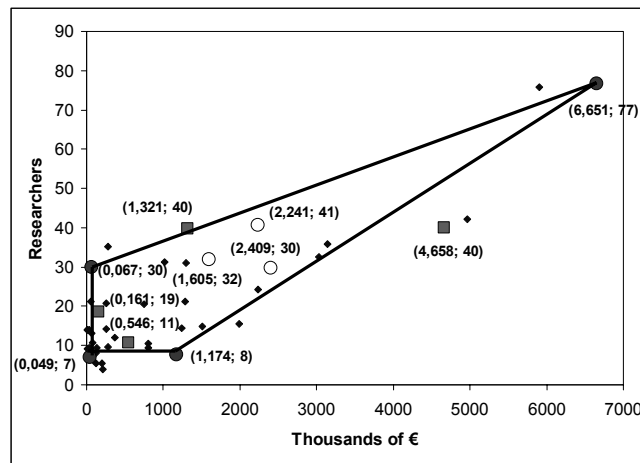


Figure 5. CCF design with restrictions for the UNAV system

The factors used are the number of researchers,  $S$ , and the funding, in the form of decimal logarithm,  $\log F$  ( $F$  is expressed in thousands of €). The response is evaluated as production,  $P$ , of scientific articles listed in the Web of Science. The best fit corresponds to a linear response with respect to the number of researchers, while with respect to the logarithm of the funding the response is simultaneously linear and quadratic. There is also a response with respect to the interaction researchers-funding, which signifies that there is a synergetic effect between the two factors.

$$P = 233 - 2.6S - 191 \log F + 44(\log F)^2 + 1.25S \log F \quad R^2 = 0.865 \quad Q^2 = 0.722$$

The goodness of the response surface represented by Eq. 1 is acceptable ( $R^2$  and  $Q^2$  are well) On the other hand, the  $F$  test of Snedecor confirms also that the fit is satisfactory at the significance level of 5%.

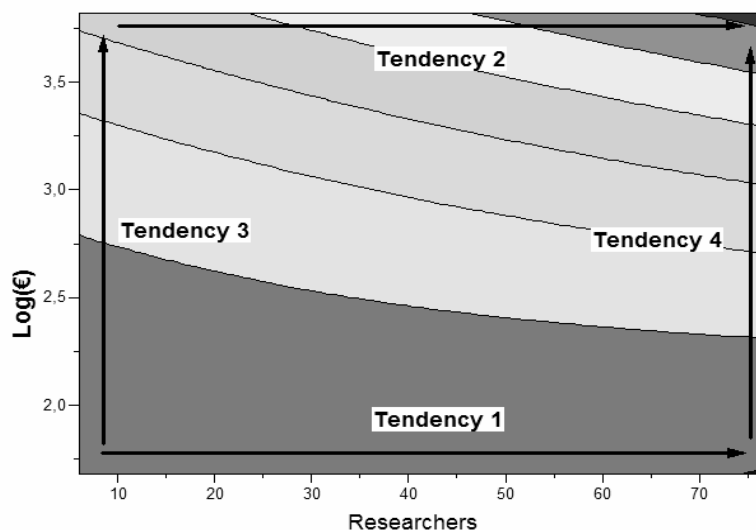


Figure 6. Flat or contour representation for the system UNAV

However, perhaps the most interesting aspect, from our viewpoint, is the generation of a graphic model that synthesises the weight of the variables chosen and their influence on the results as these variables are changed. There are two basic representations of the model: flat and contour (Figure 6), and three-dimensional or superficial (Figure 7).

From the flat and the three-dimensional representation, it is now very easy to explain the behaviour (response) of the scientific system of the UNAV according to whether the factors affecting the production of articles of the departments are affected or not.

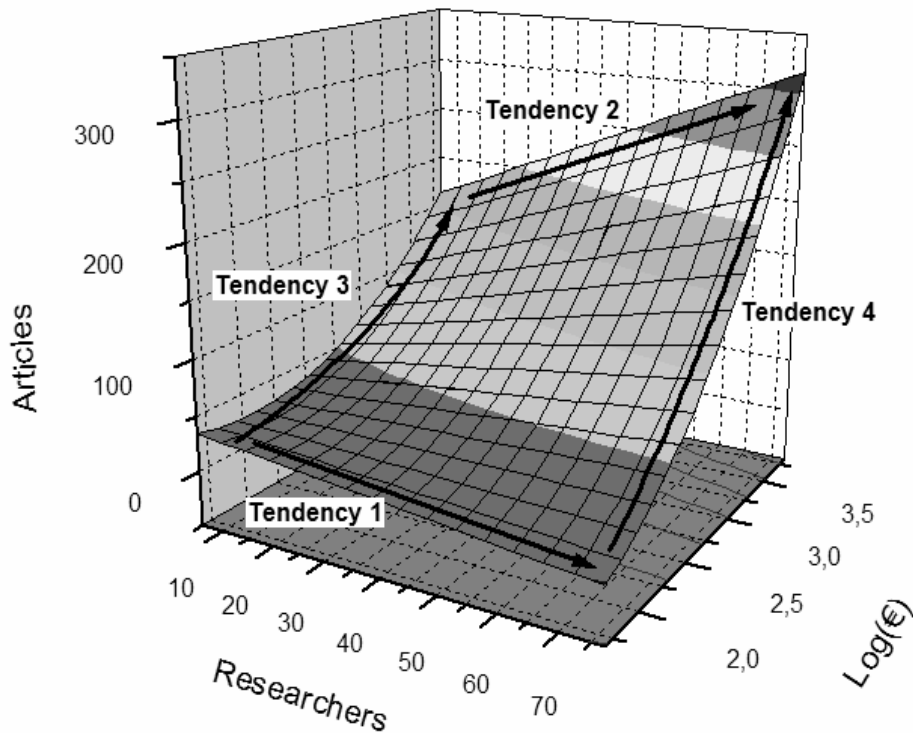


Figure 7. Three-dimensional representation of the surface of the system UNAV

*Movement one* (Tendency 1) shows what happens in the system when, under low funding, the number of researchers increases. Although it may prove unexpected, the result predicts a fall in scientific production. The explanation, however, proves attractive, when the resources are scarce, the increase in staff would prove counterproductive inasmuch as, with decreasing research funds as a consequence of the increase in researchers to attend, the capacity of producing new works tends to diminish (dark-blue fringe), as insinuated in the lower-right corner. Nevertheless, the capacity of the model in this sphere should not be exaggerated due to the scarcity of the data at this level, to their variability

*Movement three* (Tendency 3) shows the evolution in the situation of increasing funding with comparatively lower increases in staff. The possible situations covered by the blue and green segments show a progression in the results that even triple those obtained with low funding. Finally, great increases of investment are accompanied by a greater exponentially greater response, especially in the final part of the graph.

Finally, *movements two and four* (Tendency 2 and 4), which begin with few researchers having abundant financing and many researchers with little funding, the two groups converging in the form of many researchers with much funding. This inevitably marks a similar trajectory that culminates at the maximum limit of the results found in the case of the UNAV. However, the trajectories are not identical; in the first case the path is longer, given that it begins from a more deficient situation. In this sense, the general topography of the sample surface shows that it is far more effective to have fewer

human resources with better funding, than the contrary case. In other words, the economic variable is determinant in the human.

### **Conclusion**

Although we know that the impact factor (IF) of a journal does not predict the IF of an author or a particular work, what seems evident is that the prestige itself of the journal attracts citations in that we group only a certain number of works. The authors that publish in high-impact journals, which have more capacity to select from among the many works sent to them, are more visible to the scientific community, this constitutes the other determining element and closes the *virtuous* circuit of research with impact.

### **References**

- Martin, B.R. & Irvine, J. (1983): Assessing basic research: Some partial indicators of scientific progress in radio astronomy. *Research Policy*, 12, 61-92.
- Box, G.B.P. & Wilson, K.B. (1951). On experimental attainment of optimum conditions. *Journal of the Royal Statistical Society*, 13, 1-45.
- Box, G.E. P & Hunter, J.S. (1951): Multifactor experimental designs for exploring response surfaces. *Journal of the Royal Statistical Society*, 13(1), 195-240.
- Myers, R.H., Montgomery, D.C., Vining, G.G., Kowalski, S.M., and Borror, C.M. (2004), Response surface methodology: A retrospective and current literature review. *Journal of Quality Technology*, 36, 53-77.
- Jurado-Alameda, E., Bravo-Rodríguez, V., Bailón-Moreno, R., Nuñez-Olea, J. & Altmajer Vaz, D. (2003). Bath-Substrate-Flow Method for Evaluating the Detergent and Dispersant Performance of Hard-Surface Detergents. *Industrial & Engineering Chemistry Research*, 42, 4303-4310.