The International Publication Productivity of Malaysia in Social Sciences DEVELOPING A SCIENTIFIC POWER INDEX<sup>1</sup>

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The purpose of this study is to evaluate publication output and citation impact in the social sciences in Malaysia, based on Social Science Citation Index (SSCI) data, for the period 1999–2008. In addition to the analysis of trends in publication and citation patterns and national publication profiles, an attempt is made to explore the strengths and weakness of different fields, using a new mathematical index, the scientific power index (PI). The findings indicate that publication output in the social sciences has been on the increase since 1999. Mostpapers have been published in median-impact-factor journals (mean impact factor of 2.72 per paper). Internationally co-authored publications represented 77 per cent of all citations. Most of the prolific authors are from the highly productive institutions. Psychology, economics, management, and environmental studies are the dominant fields in Malaysian social sciences.

*Keywords: social sciences, Malaysia, publication output, citation impact, scientific power index (PI)* 

#### INTRODUCTION

The social sciences focus on the social worlds we live in. In the era of globalization, greater interdependence, greater technological capabilities, the increased potential for self-destructive violence, massive poverty, and widespread criminal violence all pose growing challenges for human imagination and creativity.<sup>2</sup> The globalization of the US economic crisis, the need for the international accreditation of programs, and the competitive allocation of national funds are just a few examples of the new

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environment that many countries are now facing. Globalization has created a completely new context for all social sciences. Researchers in the social sciences have required by these new challenges to engage in research that is more visible internationally. Social science research not only gives great insight into social, political, economic, cultural, and psychological problems but also provides tools and methods applicable to solving these problems. In spite of this, publication productivity studies for the social sciences in general are scarce in the literature. Much attention has been devoted to analysing the contribution of the nations to the advancement of the 'hard' and health sciences, but only a few bibliometric studies have focused on social science disciplines with the purpose of evaluating national research performance. Linda Butler has shown that between 25% and 44% of all Australian academic output in the social sciences and humanities is published in journals not indexed by ISI.<sup>3</sup> Wolfgang Glänzel and Koenraad Debackere analysed Belgium's publication output in the social sciences and the citation impact of papers indexed in the Social Science Citation Index (SSCI), concluding that standard bibliometric tools can be applied to a select set of disciplines in the social sciences in a way similar to that long practised in the sciences.<sup>4</sup> These results are also in line with earlier findings.<sup>5</sup> Mladen Koljatic and Mónica Silva compared Latin American countries' research productivity in the fields of business administration and economics from 1995 to 1999 and found that only four countries-Argentina, Brazil, Chile, and Mexico-produced substantial published research in these areas. Of the four, Chile showed the most favourable results, according to various productivity indicators.<sup>6</sup> Rolf Sternberg and Timo Litzenberger studied the publication and citation output of the biggest faculties of economics and social sciences in Germany, using various publication and citation measures based on SSCI data to explore the comparative strengths and weakness of the fields in these faculties.<sup>7</sup> Ping Zhou et al. evaluated China's publication activity and citation impact in the social sciences between 1997 and 2006;8 in addition to the comparative analysis of trends in publication and citation patterns and of national profiles, they attempted to interpret their results in both regional and global contexts. A.J. Nederhof and E. van Wijk 'developed a method to identify and map the most internationally visible research topics ... in the social and behavioural sciences, as well as the topics changed most over a decade.'9 Raúl Ramos et al.'s analysis of economics and business publications by

Spanish universities from 1994 through 2004 showed that the factors that positively influence numbers of publications and citations include tertiary programs with public financing obtained through competitive selection procedures, a large number of full-time researchers, and collaborations with international institutions.<sup>10</sup>

A few bibliometric studies relevant to Malaysian publication output in agriculture, computer science and information technology, and women's studies have been undertaken.<sup>11</sup> In Malaysia, there is a particular lack of bibliometric research on publication output and citation impact in the social sciences. This article focuses on this issue and provides an overall picture of Malaysian performance in the social sciences over the past ten years (1999–2008) in terms of the following:

- Evaluation of Malaysian publication output in the social sciences and changes in that output during the study period (1999–2008)
- Citation patterns within the research output
- Trends in collaborative activity
- Identification of highly productive institutions, prolific authors, highly cited papers and their sources
- Communication patterns of Malaysian social science publications and their impact factors
- Distribution of output in different sub-fields of social sciences and areas of strength and weakness
- Multidisciplinary overlap between SSCI and SCI

# METHODOLOGY

The present assessment of Malaysian social sciences is based on an analysis of all articles (excluding letters, notes, and reviews) recorded in the SSCI (Web of Science), published by Institute of Scientific Information (ISI, now Thomson Scientific). The group of social science disciplines is defined here as all disciplines categorized in the SSCI. The study uses time-series data for a period of ten years (1999 to 2008) for both publications and their citation impact, in order to ensure that the period of evaluation is sufficiently long to minimize the impact of fluctuations in the publication output of individual institutions and individual authors. The data for the study were downloaded from SSCI in February 2009. As a first step, all articles listing an author address in Malaysia were selected from the SSCI database (i.e., all those published by authors who listed

the name of an institution located in Malaysia in the author address field).

The bibliometric indicators used to report publication productivity are as follows: total number of papers published by a particular collection of authors and institutions during the study period; total number of citations received; average number of citations per publication; citation points; percentage of articles not cited during the study period; collaborative activity; national origins of journals; impact factors of journals as recorded in Journal Citation Report (JCR); subject categories; scientific power index (strength and weakness of fields); and multidisciplinary overlap. The statistics or indicators used have been argued to be indicators of both research quantity and quality. A full-counting or integer-counting scheme was applied. The analysis was bases on whole publication count; that is, where more than one institution collaborated on a publication, one publication was counted for each institution.

#### RESULTS

#### Output Patterns, 1999-2008

Between 1999 and 2008, Malaysian researchers published 627 papers abstracted in SSCI. Table 1 displays this output, along with the rate of growth for the ten-year study period. Analysis of the data indicates that Malaysian research output in the social sciences has experienced some ups and downs during this period. The years 2001, 2002, and 2004 saw a declining trend, followed by a steady rise from 2005 to 2008. The equivalent of 420 articles (66.99 per cent of the total) were published in the second half of the study period (2004–8). There has been a marked change since 2004 in Malaysia's publication output in the social sciences, which began to grow visibly in 2005. The average rate of growth indicates that annual Malaysian research output in the social sciences increased by about 13 per cent during the study period.

#### Citation Patterns, 1999–2009

Citation rates reflect the impact of published work on the international community. The citation rate of a paper can be considered a measure of its 'impact' (rather than of its quality or its importance). The impact of research from any country or institution can be examined by counting citations to articles produced there over a specific period. In

Year	Publica- tions	% of 1999–2008 total	% growth	Total citations	Mean citations per article	Citation points
1999	38	6.06		178	4.68	0.99
2000	53	8.45	39.47	226	4.26	1
2001	40	6.38	-24.53	207	5.17	0.97
2002	33	5.26	-17.50	205	6.21	0.99
2003	43	6.86	30.30	229	5.32	1.001
2004	35	5.58	-18.60	154	4.40	0.99
2005	58	9.25	65.71	200	3.45	0.99
2006	85	13.56	46.55	158	1.86	0.99
2007	93	14.83	9.41	113	1.21	1
2008	149	23.76	60.21	34	0.23	0.99
Total	627	100	13.08	1704		

the present study, citations to each paper were examined for the period from 1999 through February 2009 (see Table 1). As Table 1 indicates, 627 papers received 1704 citations, of which 167 are self-citations. The mean number of citations per paper for this period was 2.72 with self-citation and 2.46 without self-citation. Older publications received more citations, having a higher probability of being cited in research than more recent ones. For this reason, the SSCI citation counts of articles (times cited) are weighted according to date of publication and expressed as citation points; the weighting is based on the average number of citations of all articles examined in this study for the year in question. These average annual citation values rose from 4.68 in 1999 to 6.21 in 2002, then steadily declined to 0.23 in 2008; however, number of citation points held steady at about 1 throughout the study period. For example, an article published in 1999 (citation mean = 4.68) and cited twentythree times during the study period is given 4.91 citation points (23/ 4.68 = 4.91). Data presented in Table 2 indicate that about 50.88 per cent of the papers published by Malaysian social scientists were not cited at all in SSCI-indexed journals; the rest were cited one or more times. Further analysis of the citation data indicates that 37 per cent of papers

Citations	Papers	
n	n	%
0	319	50.88
1	88	14.03
2	61	9.73
3	34	5.42
4	27	4.31
5	18	2.87
6	12	1.91
7	13	2.07
8	6	0.96
9	6	0.96
10	6	0.96
11-20	23	3.67
>20	14	2.23
Total	627	100

 TABLE 2. Citation patterns for Malaysian

 social science research output

were cited between one and five times; 6.86 per cent were cited six to ten times; and only fourteen (2.23 per cent) were cited more than twenty times. In the ISI system as a whole, many publications receive no citations at all, and the majority are cited fewer than five times in other ISI-indexed journals.<sup>12</sup> The number of papers that achieve a high citation count is extremely small. An analysis of the data in Table 1 revealed a high and positive correlation (Pearson's r = 0.869, 99% C.I.) between publication and citation data during the study period (p < 0.001). This means that increasing the number of papers published will increase the number of citations.

# Collaboration Pattern, 1999–2008

This measure relies on correspondence addresses listed by authors to calculate the level of collaboration involved in a given publication, enabling us to distinguish three different categories of authorship:

- *Single author*—one author only (no collaboration)
- *National*—more than one author from the same institution or different institutions in Malaysia
- *International*—more than one country listed in the author address field

This indicator can be taken to represent the degree of cooperation among researchers who work in Malaysian universities and those who not affiliated with a university in Malaysia.

The numbers and percentages of articles written collaboratively between authors at Malaysian universities and those not affiliated with these institutions is reported in Table 3.

A high proportion of the articles (42.27 per cent) have at least one author who is not affiliated with a Malaysian institution; articles in *national collaboration* category account for 34.29 per cent of the sample, and 23.44 per cent were written by a single author. According to Derek De Solla Price, teamwork and collaboration are among the characteristics of 'big science.'<sup>13</sup> The results of the present study show that massive scientific collaboration, as demonstrated by a 76.56 per cent (national + international) rate of collaboratively authored papers, has become established in Malaysian social sciences. Factors such as interdisciplinarity, geopolitical affinity, mobility, and immigration at the ethnic and individual levels may have played an important part in establishing collaborative links to and within Malaysia.

Authorship	Papers published n (%)	Papers cited n (%)	Papers not cited n (%)	Total citations	Mean citations per paper
Single	147 (23.44)	88 (56.86)	59 (40.14)	169 (9.92)	1.15
National	215 (34.29)	127 (59.01)	89 (41.39)	311 (18.25)	1.45
International	84 (13.40)	39 (46.99)	44 (53.01)	233 (13.67)	2.75
(Malaysian first author)					
International	181 (28.87)	65 (35.91)	116 (64.09)	991 (58.16)	5.45
(non-Malaysian first author)					
Total	627	319	308	1704	

TABLE 3. Level of collaboration in social sciences publications, 1999-2008

The average number of citations is 4.62 for internationally co-authored publications, 1.45 for nationally co-authored papers, and 1.15 for singleauthor publications. The average number of citations to articles whose first authors are not affiliated with a Malaysian institution is 5.45. Those articles that have at least one author not affiliated with a Malaysian institution represent 77 per cent of all citations (1224/1704). An analysis of variance (ANOVA) showed that the average citation rate for articles with co-authors not affiliated with a Malaysian institution is significantly higher (df = 3, p < 0.001). The analysis also showed that collaborations between authors affiliated with a Malaysian institution and those not affiliated with such institutions were more frequent in the fields of economics and psychology. The proportion of internationally co-authored papers remained stable throughout the study period, from about 45 per cent in 1999 to about 43 per cent in 2008. For international comparison and analysis of internationally co-authored publications, all countries indicated in the address field were considered (duplicates were, of course, removed). The distribution of geographic locations gives a picture of Malaysians' collaborations with researchers in other countries. The strongest links and most important partners are the United States (21.28 per cent), the United Kingdom (19.50 per cent), and Australia (14.89 per cent). Within the region, links with Singapore (5.32 per cent), China (4.25 per cent), New Zealand (3.55 per cent), and India (3.19 per cent)—and, outside the region, Canada (3.19 per cent)—are worth mentioning. However, not only the share of collaborative papers but the strength of these links remained stable throughout the study period.

# Prolific Authors and Highly Cited Papers

Our data analysis indicated that 2324 authors contributed 627 publications to SSCI-indexed journals during the study period. The average number of authors per article was 3.71, ranging from a minimum of one to a maximum of 131.<sup>14</sup> In general, a high proportion of articles (77 per cent) were co-authored. Table 4 shows publication indicators related to article authorship.

Only twenty-five authors (as first author or co-author) contributed five or more papers. These twenty-five *prolific authors* contributed 153 papers (24.40 per cent of the total). Table 5 lists the most prolific authors, most of whom belong to highly productive institutions (see below). The work of these authors received 328 citations in all (19.25

Authors n	Papers n	%
1	147	23.44
2	181	28.88
3	133	21.21
4	81	12.92
5	27	4.31
6–10	42	6.70
>10	16	2.55
Total	627	100

TABLE 4. Authorship of published articles

per cent of the total). The per-article citation rate for the prolific authors is 2.14, less than the overall rate for the study sample. Further analysis of the data for individual authors indicates that of the twenty-five prolific authors, only six authors were cited more than the average; for the rest, the rate of citation was below the average.

Table 6 presents the data on eighteen highly cited papers, listed based on h-index factors, provided in the SSCI Citation Report. By extracting details about these highly cited papers from SSCI, it was possible to identify the institutional affiliations of their authors. The eighteen highly cited papers accounted for 589 citations, or 34.56 per cent of all citations. However, it was also apparent that none of the prolific authors is a highly cited first author; that is, that a higher level of creativity on the part of a scholar is not associated with a higher reputation. Further analysis of the highly cited papers indicated that all these papers were written in collaboration with first authors from the United States, the United Kingdom, or elsewhere, and that such papers are cited more frequently than either papers authored collaboratively by Malaysian scholars or non-collaborative papers. In other words, none of the first authors in the highly cited list are affiliated with Malaysian institutions. The most-cited authors each contributed one paper to the set of search results, considerably fewer than the most productive authors, who each contributed five or more.

Author	Institution	Papers n	Rank	Total citations	Mean citations / paper
Tang, T.C.	Monash Univ. Malaysia	12	1	37	3.08
Baharumsh, A.Z.	Univ. Putra Malaysia	9	2	22	2.44
Masjuki, H.H.	Univ. of Malaya	9	2	14	1.55
Noor, N.M.	Int'l Islamic Univ. Malaysia	9	2	28	3.11
Saidur, R.	Univ. of Malaya	8	3	14	1.75
Abdullah, M.	Univ. Kebangsaan Malaysia	7	4	7	1
Yeow, P.H.P.	Multimedia Univ. (Malaysia)	7	4	9	1.28
Agus, A.	Univ. Kebangsaan Malaysia	6	5	16	2.66
Low, W.Y.	Univ. of Malaya	6	6	12	2
Ahmed, M.	World Fish Ctr.	5	7	28	5.60
Azali, M.	Univ. Wales Coll. Cardiff	5	7	11	2.20
Chong, S.C.	Louisiana State Univ., USA	5	7	2	0.40
Furnham, A.	Univ. Coll. London, UK	5	7	28	5.60
Habibullah, M.S.	Univ. Putra Malaysia	5	7	12	2.40
Husain, N.	ADMACS Corp. Consultants	5	7	4	0.80
Kamalanabhan, T.J.	Univ. Telekom	5	7	9	1.80
Liew, V.K.S.	Univ. of Malaya	5	7	21	4.20
Mahlia, T.M.I.	Univ. of Malaya	5	7	3	0.60
Naing, L.	Univ. Brunei, Univ. Sains Malaysia	5	7	3	0.60
Quek, K.F.	Monash Univ. Malaysia	5	7	12	2.40
Rasiah, R.	Univ. of Malaya	5	7	4	0.80
Sen, R.N.	Multimedia Univ.	5	7	10	2
Sqiures, D.	SW Fisheries Sci. Ctr., USA	5	7	21	4.20
Swami, V.	Univ. Westminster, UK	5	7	1	0.20
Zainab, A.N.	Univ. of Malaya	5	7	0	0.00

# TABLE 5. Most prolific authors and their citation numbers

# Highly Productive Institutions

Research publications in the social sciences come from a number of agencies. As expected, however, the major output is from universities. In the present study, the total output of 627 publications came from 702 institutions; of these, institutions contributing more than ten publications between 1999 and 2008 were considered 'highly productive.' These fifteen institutions contributed 568 (90.59 per cent) of the total

# TABLE 6. Most highly cited papers

C.P. Van Schaik, M. Ancrenaz, G. Borgen, et al.129Science 299 (2003): 102–5129A. Terracciano, A.M. Abdel-Khalek, N. Adam, et al.40Science 310 (2005): 96–10014.J.H. Liu, B. Lawrence, C. Ward, et al.40Asian Journal of Social Psychology 5 (2002): $3-20$ 33J.A. Harding, K. Popplewell, R.Y.K. Fung, et al.35Computers in Industries 44 (2001): $51-65$ 53K.Y. Wong33Industrial Management & Data Systems 105 (2006): $261-79$ 33S. Yahya & B. Kingsman33Journal of the Operational Research 50 (1999): $916-30$ 34M.B. Martinsons & P.K.C. Chong29Human Relations 52 (1999): $123-52$ 34M.H. Bond, K. Leung, A. Au, et al.27Journal of Cross-Cultural Psychology 35 (2004): $548-70$ 7R. Belderbos, G. Capannelli, K. Funkao27World Development 29 (2001): $189-208$ 26Lancet 368 (2006): $1357-64$ 24J. McMorrow, M.A. Talip25Global Environmental Change—Human and Policy Dimensions2111 (2001): $217-30$ 24M.G. Helander, H.M. Khalid24Applied Ergonomics 31 (2000): $609-19$ 22C.K. Liam, K.H. Lim, C.M.M. Wong, et al.23International Journal of Tuberculosis and Lung Disease 3 (1999): $300-309$ J.R. Nielsen, P. Degnbol, K.K. Viswanathan, et al.22Marine Policy 28 (2004): $151-60$ 24M.Y Intersum, R.P. Roetter, H. van Keulen, et al.19Land Use Policy 21 (2004): $101-13$ 19<	Author(s) and publication data	Citations
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Institution	Papers		Rank
	n	%	
Univ. of Malaya	108	17.22	1
Univ. Sains Malaysia	73	11.64	2
Univ. Kebangsaan Malaysia	69	11.01	3
Univ. Putra Malaysia	61	9.73	4
Monash Univ. + Monash Univ. Malaysia	42 (25 + 17)	6.70	5
Univ. Teknol. MARA	39	6.22	6
Multimedia Univ.	38	6.06	7
Int'l Islamic Univ.	36	5.74	8
Nat'l Univ. Malaysia	21	3.35	9
Univ. Malaysia Sarawak	19	3.03	10
World Fish Ctr.	14	2.23	11
Univ. Pertanian Malaysia	13	2.07	12
Univ. Malaysia Sabah	13	2.07	12
Univ. Nottingham	12	1.91	13
Nanyang Technol Univ.	10	1.60	14
Other $(n = 687)$	59	9.41	_
Total	627	100	-

# TABLE 7. Publication output of prolific institutions, 1999–2008

output, while the remaining 9.41 per cent came from institutions scattered all over Malaysia and elsewhere in the world. Four institutions contributed more than fifty papers each; eleven institutions contributed more than ten but fewer than fifty; and the rest contributed less than ten each. Of the fifteen prolific institutions listed in Table 7, two are international universities (Monash University in Australia and Nottingham University in the United Kingdom) and one is an international institution located in Malaysia (the World Fish Center). The University of Malaya and University Sains Malaysia clearly stand out from other institutions in terms of their absolute publication numbers, followed by University Kebangsaan Malaysia and University Putra Malaysia.

# Communication Patterns of Malaysian Social Scientists

The 627 papers published by Malaysian scientists during the study period appeared in 336 journals published in twenty-five different

Journal country of origin	Papers published <i>n</i> (%)	Journals n (%)
United Kingdom	316 (50.40)	157 (46.73)
United States	137 (21.85)	86 (25.59)
Netherlands	62 (9.89)	34 (10.12)
Malaysia	13 (2.07)	3 (0.89)
Australia	12 (1.91)	6 (1.79)
New Zealand	12 (1.91)	3 (0.89)
Switzerland	10 (1.60)	4 (1.19)
Other (18 countries)	65 (10.37)	43 (12.80)
Total	627	336

TABLE 8. Distribution of output among international and domestic journals

countries, including Malaysia. These journals typically or occasionally contain articles by Malaysian researchers. Of the 336 journals, 91 (27.08 per cent) are not fully indexed in SSCI but are listed in other ISI databases (selectively covered by SSCI) or are newly added journals that have not yet been listed. It should be noted that 62.36 per cent of articles appeared in 108 journals and 37.64 per cent in the remaining 228. Data analysis of the distribution of scientific output in international and domestic journals (Table 8) indicates that within the study sample, Malaysian scientists published about 98 per cent of their papers in international journals and only 2 per cent in domestic journals. This may be because equivalent Malaysian journals are not indexed by SSCI. The three Malaysian journals represented in the sample were Malaysian Journal of Library and Information Science, Asia-Pacific Journal of Public Health, and Tropical Biomedicine. Of the papers published in international journals, the largest number appeared in journals originating in the United Kingdom (50.40 per cent), the United States (21.85 per cent), and the Netherlands (9.89 per cent).

Journals (n = 19) were included in the list of highest total article counts if they met the threshold count of five articles. Journals with high article counts are most likely to be published in the United Kingdom, the

Journal title	Country of origin	Papers n
Applied Economics Letters	United Kingdom	22
Total Quality Management	United Kingdom	18
Energy Policy	United Kingdom	14
Applied Economics	United Kingdom	12
Educational Technology & Society	New Zealand	10
Industrial Management & Data Systems	United Kingdom	8
Third World Quarterly	United Kingdom	8
Total Quality Management & Business Excellence	United Kingdom	8
Malaysian Journal of Library and Information Science	Malaysia	7
International Journal of Industrial Ergonomics	Netherlands	6
Journal of Cross-Cultural Psychology	United States	6
Marine Policy	United Kingdom	6
Asian-Pacific Journal of Public Health	Malaysia	5
British Journal of Educational Technology	United Kingdom	5
Economics Letters	Switzerland	5
Japan and the World Economy	Netherlands	5
Journal of Business Ethics	Netherlands	5
Journal of Contemporary Asia	Philippines	5
Physica A—Statistical Mechanics and Its Applications	Netherlands	5

# TABLE 9. Journals with highest total numbers of articles

Netherlands, the United States, Malaysia, New Zealand, Switzerland, or the Philippines. The list of preferred journals is given in Table 9; the three journals with the highest article counts (*Applied Economics Letters*, *Total Quality Management*, and *Energy Policy*) are fully indexed in SCI and selectively covered by SSCI.

Impact indicators are a standard instrument for evaluating the quality of journals (and, therefore, of articles published in those journals).<sup>15</sup> A high journal impact factor (IF) indicates mainstream readership and mainstream connectivity. Since the IF of a journal varies by discipline and journal type, IF for journals fully covered by SSCI was used for the purposes of this study; five-year IF and one-year IF (where five-year IF was not available) as reported in the 2007 ISI Journal Citation Report (JCR) were used. Journals for which an IF value was available were

divided into three categories: low IF (IF  $\leq$  1), medium IF (1 < IF < 2), and high IF (IF > 2). Those journals for which the JCR did not give an impact factor for any of the relevant years were assigned the overall average value. Data analysis indicated that 57.89 per cent of papers in the sample were published in medium-IF journals, 7 per cent in high-IF journals, and 35.11 per cent in low-IF journals. The average impact factor of SSCI-indexed journals in which articles from Malaysia appeared was 1.252.

#### Publication and Citation Shares of Individual Fields

In order to assess the publication record within individual fields, the output data were classified in thirty-nine subject categories based on the SSCI subject classification (see Table 10). Because different sub-fields of *psychology* are homogeneous, these sub-fields are treated in the aggregate; similarly, *business* and *business finance*, and *area studies* and *Asia studies*, were merged together. Distribution of output in the fields listed in Table 10 indicates that *economics* tops the list with about 14.08 per cent of the total output, followed by *psychology* and *management*; these three fields together account for about one-third (33.64 per cent) of the total output. Eight fields—*environmental studies; public, environmental & occupational health; education & educational research; business & finance; planning & development; information science & library science; psychiatry; and <i>area studies & Asian studies*—account for another 39.88 per cent. The remaining 26.48 per cent of the output is scattered among twenty-eight other fields (see Table 10).

The overall values for the ten-year study period hide potential catchup processes between the individual fields over the course of time. To obtain more stable patterns, the study period was divided into two time spans: 1999–2003 and 2004–2008. In 2004–2008 more attention was given to *economics, environmental studies, business & finance, education* & *educational research, public, environmental & occupational health,* and *psychology.* An examination of publication output in these two periods indicates that output in most fields have increased during 2004–2008 relative to 1999–2003. In the case of *management, planning & development, rehabilitation,* and *women's studies,* however, output decreased in 2004–2008 relative to 1999–2003.

To analyse the scientific activity of a country in a given field, investigating the country's citation impact in that field is also important, since

Field	Publications 1999–2003	2004-8	Total	Not cited	Citations	Mean citations / paper	PI-n*	Ci/TC	Pi-n × Ci/TC	n/Tn	Id
Economics	28	60	88	43	183	2.08	45	0.107	4.815	0.134	4.94
Psychology	30	40	70	26	249	3.56	44	0.146	6.426	0.081	6.507
Management	30	23	53	24	166	3.13	29	260.0	2.813	0.075	2.888
Environmental studies	7	40	47	21	160	3.40	26	0.093	2.418	0.065	2.483
Public, environmental, &	3	38	41	26	35	0.85	15	0.021	0.315	0.081	0.39(
occupational health											
Education & educational research	6	31	40	19	64	1.60	21	0.037	0.777	0.059	0.83
Business and finance	8	23	31	17	59	1.90	14	0.034	0.476	0.053	0.529
Planning and development	16	10	26	15	88	3.38	11	0.051	0.561	0.047	0.60
Information science and	6	14	23	11	42	1.83	12	0.024	0.288	0.034	0.322
library science											
Psychiatry	6	13	22	3	95	4.32	19	0.055	1.045	0.009	1.05
Area studies & Asia	10	10	20	15	8	0.40	2	0.004	0.02	0.047	0.06
studies											
Geography	4	14	18	2	96	5.33	13	0.056	0.728	0.015	0.74
Sociology	4	14	18	10	15	0.83	8	0.008	0.064	0.031	0.09
Social sciences,	8	8	17	8	54	3.18	6	0.031	0.279	0.025	0.30
interdisciplinary											
Ergonomics	8	8	16	4	52	3.25	12	0.030	0.36	0.012	0.37:
International relations	٢	11	16		48	3	6	0.028	0.252	0.022	0.27
Anthropology	°	12	15	8	40	2.66	~	0.023	0.161	0.025	0.18
Urban studies	٢	6	14	7	58	4.14	~	0.034	0.238	0.022	0.26
Health policy and services	1	6	10	3	35	3.50	7	0.020	0.14	0.009	0.14

Substance abuse	1	6	10	3	20	2	~	0.011	0.077	0.009	0.086
Linguistics	7	9	8	4	4	0.50	4	0.002	0.008	0.012	0.02
Nursing	7	9	8	4	19	2.37	4	0.011	0.044	0.012	0.056
Women's studies	5	7	~	3	14	6	4	0.008	0.032	0.009	0.041
Family studies	3	3	9	3	18	3	3	0.010	0.03	0.009	0.039
Ethics	1	4	2	3	8	1.60	7	0.004	0.008	0.009	0.017
Hospitality, leisure, sports,	1	4	Ŋ	3	Ŋ	1	7	0.0029	0.006	0.009	0.015
& tourism											
Law	3	7	Ŋ	1	14	2.80	4	0.008	0.032	0.003	0.035
Rehabilitation	4	1	Ŋ	3	7	0.40	7	0.001	0.002	0.009	0.011
Demography	1	3	4	3	1	0.25	1	0.0005	0.0005	0.009	0.0095
Social sciences, biomedical	7	7	4	1	18	4.50	3	0.010	0.03	0.003	0.033
Social work	3	1	4	3	4	1	1	0.002	0.002	600.0	0.011
Communication	1	7	3	3	0	0	0	0	0	600.0	0.009
Political sciences	1	7	3	3	0	0	0	0	0	600.0	0.009
Ethnic studies	0	7	7	7	0	0	0	0	0	0.006	0.006
Gerontology	1	1	6	1	3	1.50	1	0.0017	0.0017	0.003	0.0047
Public administration	0	7	7	1	6	1	1	0.0011	0.0011	0.003	0.0041
Transportation	1	1	7	0	25	12.50	9	0.0146	0.0292	0	0.0292
Social science, mathematical	0	2	5	7	0	0	0	0	0	0.006	0.006
methods											
History of social science	0	1	1	1	0	0	0	0	0	0.003	0.003
* Total $PI = 23.4665$ , $M = 0.6017$											

this provides information about how publications from that country are perceived by the international community. Within the present study sample, citation patterns and publication activity are not similar across fields. Based on the data in Table 10, articles published in *psychology, economics, management*, and *environmental studies* are cited more frequently than those published in other fields. Average citations per article for different fields show that citation practices differ markedly. The number of citations per article for fields represented in the sample by a very small number articles may be very high. For example, the 2 articles published in *transportation* were cited a total of 25 times, and no non-cited articles were published in this field, yielding a mean of 12.5 citations per article. The varying nature of citation practices means that the average can be disproportionately affected by a single highly cited publication. The smaller the number of publications analysed, the greater the effect such an item will have on the average.

As is obvious from the table, the rankings for citation measures can be seen to differ significantly from those for publication measures. For this reason, only an evaluation that uses a broad range of publication and citation measures can do justice to the strength or weakness of an individual discipline. In order to measure the areas of strength and weakness, the author developed a scientific *power index* (PI). The PI characterizes the relative research power a country devotes to a given field and takes into consideration the effect of publication and citation as well as the size of the field. PI is the scientific power of the country in a given science field. The index can be applied to the strength and weakness of an individual field among the other fields in a country to create a holistic view of the country's scientific activity. PI can be simply defined as follows:

 $PI = (P_{ij} - n_{ij}) \times (C_{ij}/TC_i) + (n_{ij}/Tn_i)$   $PI_s = PI > M$   $PI_w = PI < M$ where

 $P_{ij}$  = Total number of publications of a country (*i*) in a field (*j*) within the set of search results

 $n_{ij}$  = Number of non-cited publications of a country (*i*) within the set of search results

 $C_{ij}$  = Number of citation of a country (*i*) in a field (*j*) within the set of search results

 $TC_i$  = Total number of citations of a country (*i*) in all fields within the set of search results

 $Tn_i$  = Total number of non-cited publication of a country (*i*) in all fields within the set of search results

M = The average PI for a country for all fields within the set of search result

In this equation, the first expression  $(P_{ij} - n_{ij})$  indicates the number of cited publications. The second expression  $(C_{ij}/TC_i)$  is used to normalize the differences in citation count in each subject category or field. The third expression  $(n_{ij}/T_n)$  is used to normalize the differences in the number of non-cited publications in each subject category or field.

 $PI_s$  indicates fields with an above-average value for PI, or *strong fields*;  $PI_w$  indicates fields with a below-average PI, or *weak fields*. A high PI indicates mainstream or dominant disciplines. Since citation conventions differ among fields, the index is normalized by the average number of citations or publications. Data sets for individual fields are subsets of the full data set, which includes all the fields. Thus,  $n_i/T_{ni}$  is the average number of non-cited papers and  $C_i/TC_i$  the average number of citations for all fields under consideration. The figures in Table 10 show this relative difference explicitly. Table 10 shows data and PI calculations for all fields under study; based on the figures in Table 10, Table 11 ranks the top ten fields by publication output, citation rate, mean citations per article, and PI, showing how the to ten fields differ on these four major indices.

Overall, the data in Tables 10 and 11, which take into account the locational strengths and weakness of individual fields, show low values in relation to citations per article. The performance of *economics* changes when PI is used as a measure of scientific power; although economics is still among the top-ranked fields, the order of the fields and the intervals between them change significantly in comparison with the ranking discussed thus far. *Psychology* (PI = 6.507), *economics* (PI = 4.949), *management* (PI = 2.888), *environmental studies* (PI = 2.483), *psychiatry* (PI = 1.054), *education & educational research* (PI = 0.836), *geography* (PI = 0.743), and *planning & development* (PI = 0.608) have

Total publications	Total citations	Mean citations / paper	PI
Economics	Psychology	Transportation	Psychology
Psychology	Economics	Geography	Economics
Management	Management	Social sciences, biomedical	Management
Environmental studies	Environmental studies	Psychiatry	Environmental studies
Public, environmental, & occupational health	Geography	Urban studies	Psychiatry
Education & educational research	Psychiatry	Psychology	Education & educational research
Business & business finance	Planning & development	Health policy & services	Geography
Planning & development	Education & educational research	Environmental studies	Planning & development
Information science &	Business &	Planning &	Business & finance
library science	finance	development	
Psychiatry	Urban studies	Ergonomics	Public, environmental, & occupational health

TABLE 11. Top ten fields ranked by total publication output, total citations, mean citations per paper, and PI

above-average PI values (mean PI = 0.601); thus, these eight fields are strong, and the remaining fields weak, among social-science fields in Malaysia. *Psychology, economics, management*, and *environmental studies* are the strongest fields as measured by PI values, meaning that these are the mainstream or dominant fields in Malaysian social sciences (see Tables 10 and 11).

This index was intended to address the differences in ranking according to other bibliometric indicators, such as total number of papers or total number of citations. The data analysis shows that the index is effective in comparing the strength and weakness of a number of fields and producing a single numerical criterion. It should be noted that the PI criterion considers both the quantity and the quality of research by

carefully normalizing differences of subject category or field. However, results are dependent on the method used for the subject category; for example, sub-fields may be considered individually or in the aggregate. Also, a special note of caution is required concerning the small numbers of publications tabulated in some research fields or subject categories. The index described here has been used in the context of national publication; however, it can also be used in the context of international publication. In principle, the method described can be applied to other fields within the same country or among countries. The method could be refined, for example by including the number of authors in the input data for each field.

## Multidisciplinary Overlap

Structurally, the SSCI database includes some journals that are fully covered but also others journals that are covered selectively: these journals are fully covered by other ISI databases, but only selected papers are indexed in the SSCI. Within the present study sample, of the 627 papers 205 are also indexed in the Science Citation Index (SCI), indicating a 32.70 per cent overlap between SSCI and SCI. Because of this overlap, full counting of papers indexed in any of these databases will be additive (i.e., will result in multiple counting of some papers). Moreover, ninetyfour of the cross-indexed papers (14.99 per cent) were assigned an SCI subject category (e.g., urology & nephrology, oncology, pediatrics, infectious diseases, nutrition & dietetics) but were not assigned an SSCI subject category. Finally, the authors of these papers do not belong to the social sciences community. Knowledge sharing among knowledge workers within interdisciplinary communities may be critical for new discoveries and for a more comprehensive and accurate understanding of phenomena. This situation, as also noted by Glänzel, causes problems in bibliometric analysis, especially complicating correct subject assignment and the determination of appropriate reference standards for citation analysis.16

# DISCUSSION AND CONCLUSION

The present study constitutes an attempt to quantify and describe the publication record of Malaysia in the social sciences, a baseline assessment of the state of the art that may help illuminate policy decisions to promote research within the country. The number of SSCI-indexed

publications by Malaysian researchers shows an increase from thirtyeight in 1999 to 149 in 2008; the year 2005 can be considered a turning point. Results show substantial differences among fields in terms of publications and citations. Malaysian researchers are becoming visible internationally in fields such as psychology, economics, and management, whereas the country produces very little in some other large socialscience disciplines such as political science and communications. Different nations may emphasize research in different fields. In terms of publication activity, the Malaysian pattern is somewhat like that of the EU countries identified by Zhou et al.,<sup>17</sup> whose publication activity is close to the world average in economics and business administration; above the average in psychology; and below the average in social, political, and communication sciences. Among Asian countries, China, Singapore, and South Korea are relatively more active than the world average in economics and business administration, and below the average in psychology and in social, political, and communication sciences. Japan's publication activity in psychology is more dynamic than the world average.

The degree of cooperation among researchers working in Malaysian universities and those from other national or international institutions was significant during the study period. A sizeable proportion of articles were written collaboratively—over 76 per cent of the total publication count. Of 627 papers, 265 (42.27 per cent) were published in collaboration with at least one author from outside Malaysia, reflecting in part the increasing international cooperation between university researchers from Malaysia and those in other part of the world. Malaysians' international collaboration pattern was maintained throughout the complete period. Researchers in the United States, the United Kingdom, and Australia were the most likely to collaborate with researchers in Malaysia. It is interesting to note that institutions in Australia (Monash University) and the United Kingdom (Nottingham University) are supporting a proportion of Malaysian scientific research efforts. This growing international collaboration improves the knowledge level of Malaysian scholars and helps Malaysian researchers to better merge into international community. Such collaboration may also help the international community better understand Malaysia. However, an over-reliance on collaborators in developed countries, although successful so far, may limit future development of research in Malaysia. The average citation rate for articles

with co-authors not affiliated with a Malaysian institution is significantly higher; Kun-Yang Chuang et al., in a bibliometric and citation analysis of research in Taiwan, also found that internationally co-authored papers had higher visibility than others.<sup>18</sup>

The link between authoring internationalization and citation internationalization is strong. Based on this link, we can hypothesize that the higher the international cooperation of any given developing country, the higher its citation output, as recorded in the ISI. The differences in rankings for measures of publication output and citation distribution are large, which justifies the joint use of both measurement categories via the scientific power index (PI). From a bibliometric perspective, empirical results demonstrate that a variety of measures are necessary to adequately identify the relative strength and weakness of selected fields. Using a balanced approach to evaluate the relative strength and weakness of the disciplines allows each individual discipline to determine its own position by comparison with other disciplines within the same country or with the same discipline in other countries. There is a 32.70 per cent overlap in the study sample between SSCI and SCI; such overlap may lead to multiple counting of a country's publication activity, and especially to bias in subject, bibliometric, and citation analysis. Moreover, knowledge sharing among researchers within interdisciplinary communities may be critical. Under no circumstances, however, should analysis attempt to justify the heterogeneity or homogeneity of the publication output of the disciplines.

Although international co-authorship is in general accepted as a basically positive phenomenon, extensive collaboration might be used as means of raising citation effects. Because of extensive international coauthorship, a number of non-Malaysian authors and institutions were identified among the prolific authors, highly productive institutions, and highly cited papers in this study; thus, national bibliometric indicators such as publication or citation counts based on the full-counting scheme are additive, that is, they can be summed up over countries. If the impact of a paper is the number of citations it receives, and if the publication rate is the number of papers published, it might be logical to divide that impact and publication by the number of authors involved. Analyses that fail to take the number of authors into account will not produce accurate research results in terms of publication and citation indices.

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