



HEALTH SCIENCES

Brazilian Publication Profiles: Where and How Brazilian authors publish

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Abstract: Publishing profiles can help institutions and financing agencies understand the different needs of knowledge areas and regions for development within a country. Incites[®] (Web of Science) was used to see where Brazilian authors were publishing, the impact, and the cost of this publishing. The USA was the country of choice for publishing journals, along with Brazil, England, and the Netherlands. While Brazilian authors continue to publish in hybrid journals, they are more often opting for closed access, with 89% of the papers published in Brazil being open access, compared with 21% of papers published abroad. The correlation between the cost of publishing and the number of citations was positive and significant. Publishing patterns were different depending on the area of knowledge and the Brazilian region. Stagnation or reduction in publications with international collaboration, industry collaboration, or in high impact open access journals may be the cause of a reduction in citation impact. These data can help in elaborating public and institutional policies for financing publications in Brazil, especially when looking at unfavourable changes in currency exchange rates.

Key words: impact, OECD area, cost, journal, publisher.

INTRODUCTION

Understanding publication patterns is important, not only to evaluate investments in scientific projects but also to see where investments are necessary to meet national objectives and priorities. There are marked differences between scientific disciplines and research fields, including their publishing practices and languages (Mathies et al. 2020; McManus & Neves 2020). Many metrics associated with research publishing and impact significantly correlate to university reputation (Linton et al. 2013), but these institutions rarely opine on where research is published, as this is largely left to the individual researcher. Many questions arise when researchers decide where to publish their research. These include language, quality

of research, the possibility of rejection, regional or international importance, tradition, as well as publishing costs (James 2017). Journal selection for publishing research is important in terms of visibility and impact. Many countries have signed Open Access (OA) agreements (including Brazil) and have started financing researchers to this end (Suber 2012).

Critical to the interest in the bibliometric dimensions of journals is the growth of institutional or individual evaluation of publication-quality (Hall 2011). The development of national research quality evaluations and metrics with corresponding effects on financial resources for universities and individuals has clear implications for economic, human resource management and research practice, as well as influencing where scholars publish and

therefore the overall development an academic field (Visser 2009), leading to the undertaking of bibliometric studies to develop rankings of academic leadership, influence, journals, and research quality. The use of bibliometric measurement can shape researchers' (particularly younger ones) choice of where to publish and may focus them more towards international (English-language) peer-reviewed journals (Hammarfelt and de Rijcke 2015).

The objective of this study is to see where Brazilian authors publish, how much this costs and how this affects the citation of the papers.

MATERIAL AND METHODS

Data from this study were obtained from Incites (<https://incites.clarivate.com/>) using the journal and articles tabs, from 2010 to 2019. The main categories of the Organisation for Economic Co-operation and Development (OECD 2007) were used in this study for classification purposes. This scheme uses six broad subject categories for publishing data: (1) natural sciences, (2) engineering and technology, (3) medical and health sciences, (4) agricultural sciences, (5) social sciences, and (6) humanities. The discussion here is based on these broad fields.

Changes in numbers of publications and quality indicators on a journal basis were evaluated including country of publisher, Category Normalised Citation Index (CNCI - dividing the actual count of citing items by the expected citation rate for documents with the same document type, year of publication and subject area), Journal Normalized Citation Impact (JNCI - instead of normalising per subject area or field, it normalises the citation rate for the journal in which the document is publishing), % papers in top 10%, % Open access (OA), %

papers in Q1 journals as well as indicators for international and industry collaboration.

A principal component analysis was carried out using quality indicators for journal data (above) as well as cluster analysis. All statistical analyses were performed using SAS (Statistical Analysis System Inc, Cary, North Carolina).

Costs of publishing were estimated for the top 50 journals (78,830 papers, 18.5% total production) using information from journal homepages, Scielo (www.scielo.br) and DOAJ. When page charges were for published article 7 pages were assumed, while if for word this was 20 pages. In all cases, discounts for members of specific societies were applied. If the journal was a hybrid, the % open access papers for Brazilian Authors from Incites® was used. Translations were assumed to be 10% of the papers published in English at (Brazilian Reais) BRL1500 per paper. Where the production of a translation certificate was obligatory or recommended these increased to 90 and 50%, respectively (Björk & Solomon 2014, 2015). All values were transformed into dollars at (United States Dollar) USD1 = BRL4.3.

RESULTS

There were a total of 14,317 journals or documents registered as having one or more article from a Brazilian author in the period of 2010-2019. Of these, around 2100 are responsible for 80% of the papers published by Brazilian authors (Figure 1).

Approximately 20% of the journals contained 80% of the papers (Table I) except for Agricultural Sciences, where this value was around 10%, showing a higher dispersion among journals in this area of knowledge. The total of journals is greater than the country total as journals and papers may appear in more than one area of knowledge.

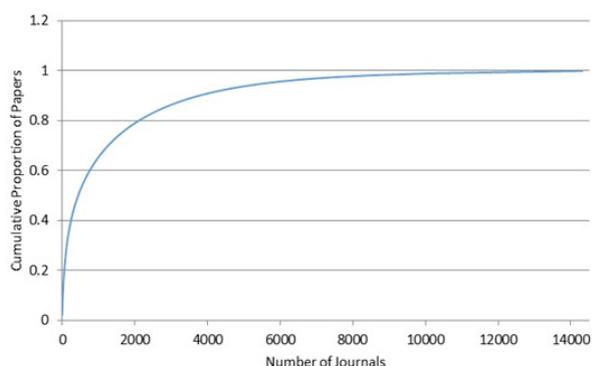


Figure 1. Cumulative proportion of papers per journal by Brazilian authors (Incites® 2009-2019).

Each area of knowledge shows a different profile as to country of origin of the journals where Brazilian authors publish and the number of papers published in these journals (Figure 2 and Supplementary Material, Figure S1) as well as the number of journals and papers per quartile in each area of knowledge (Figure 3 and Figure S2). In almost all areas, there is a tendency to publish more papers in Brazilian journals than in journals from other countries, but only in Agricultural Sciences and Humanities are the highest proportion of papers published in Brazilian journals. Overall, Brazilian journals publish the second-highest number of papers (24%), after the USA (27%).

When looking at the quartiles of where Brazilian papers are published, the differences between areas again become apparent. When the papers are published in Brazil, there

is a tendency to publish in lower quality journals (maybe due to the lack of these in several knowledge areas), but this is not true when Brazilians publish in the exterior. While Agricultural Sciences follow the same trend, Brazilians in Engineering & Technology, Medical & Health, Natural and Social sciences tend to publish more in higher quality journals. The documents in the humanities tended to be “not defined” as they were mainly books and so not subject to journal quartile analyses. Overall, the citation index (CNCI) was higher in Q1 journals (1.69), decreasing to Q4 (0.32). Q1 journals in Brazil had a medium impact of 0.58 and Q4 (0.22).

Numbers of publications in Brazilian journals has been falling in the areas of Medical & Health, Natural and Agricultural Sciences since 2011, while increased in the Engineering & Technological sciences. The decrease in the number of papers published in Brazil may reflect an increase in publications in journals not registered in the Web of Science. In contrast, there was an increase in Brazilian publications abroad in all areas until more recently when this has stabilised or has started to fall (Figure 4). As seen in Figure 2, the major publishing countries, along with Brazil, are the USA, England and the Netherlands (>75% in all cases). While papers in the Medical & Health area have recently decreased in these countries (Figure

Table I. Summary of publication distribution by Brazilian authors (Incites® 2009-2019).

	Number of Journals	Number of Journals with 80%	Number of papers	% of Journals with 80%
Agriculture	988	102	66342	10.33
Eng & Tech	3013	515	83834	17.09
Humanities	1072	234	5851	21.83
Medical & Health	4315	808	142355	18.72
Natural Sciences	5756	1041	203811	18.08
Social Sciences	3153	670	21819	21.25
All	14319	2142	426239	14.96

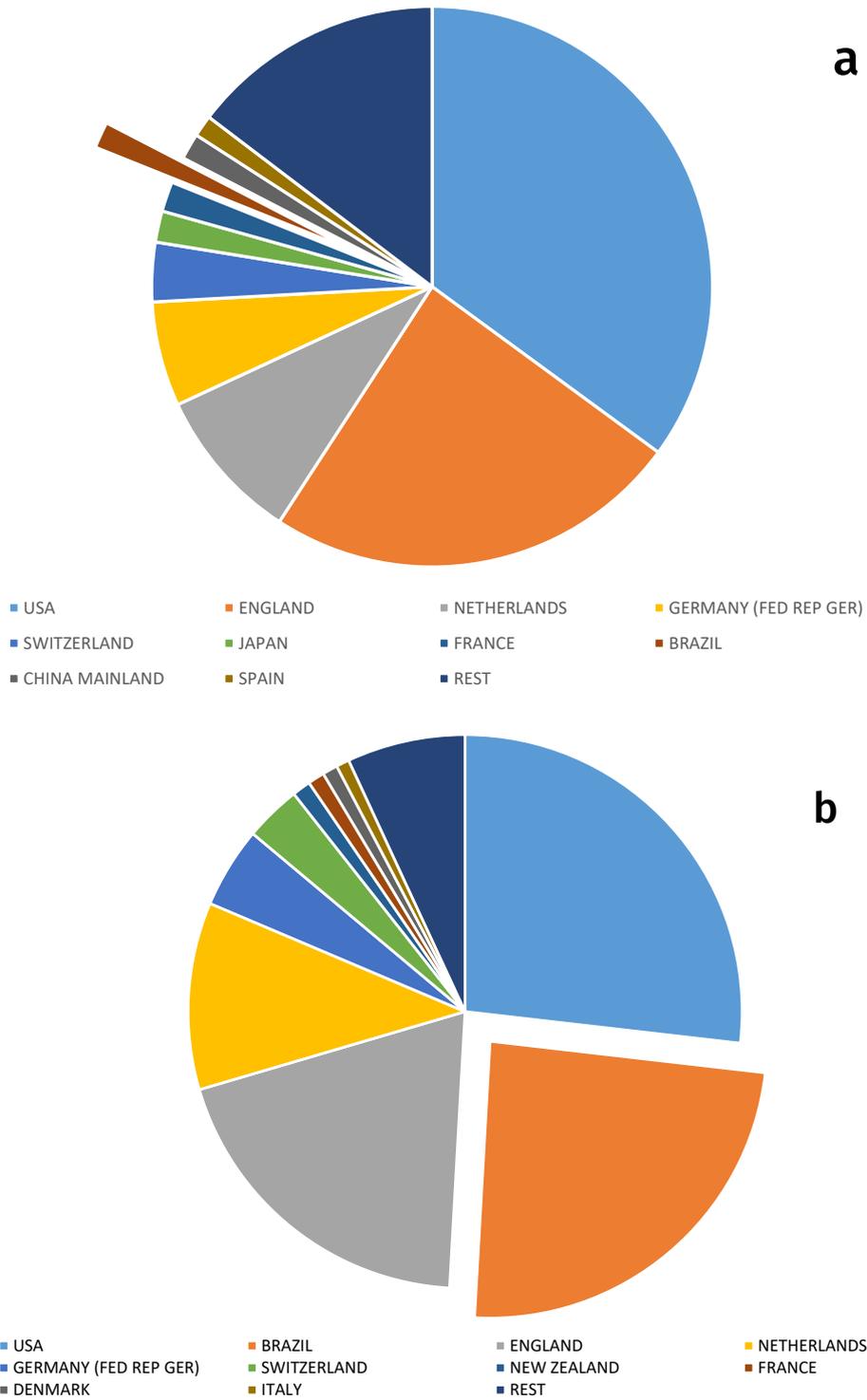


Figure 2. Distribution of journals (a) and Documents (b) by journal country of origin publishing Brazilian Authors (Incites © 2009-2019). (Brazilian journals are highlighted in each figure).

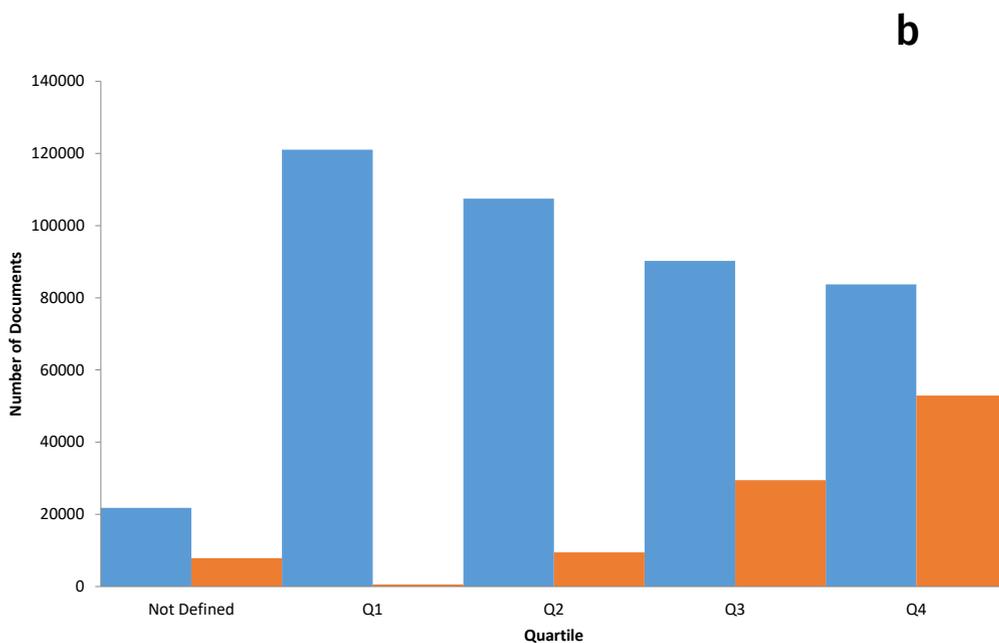
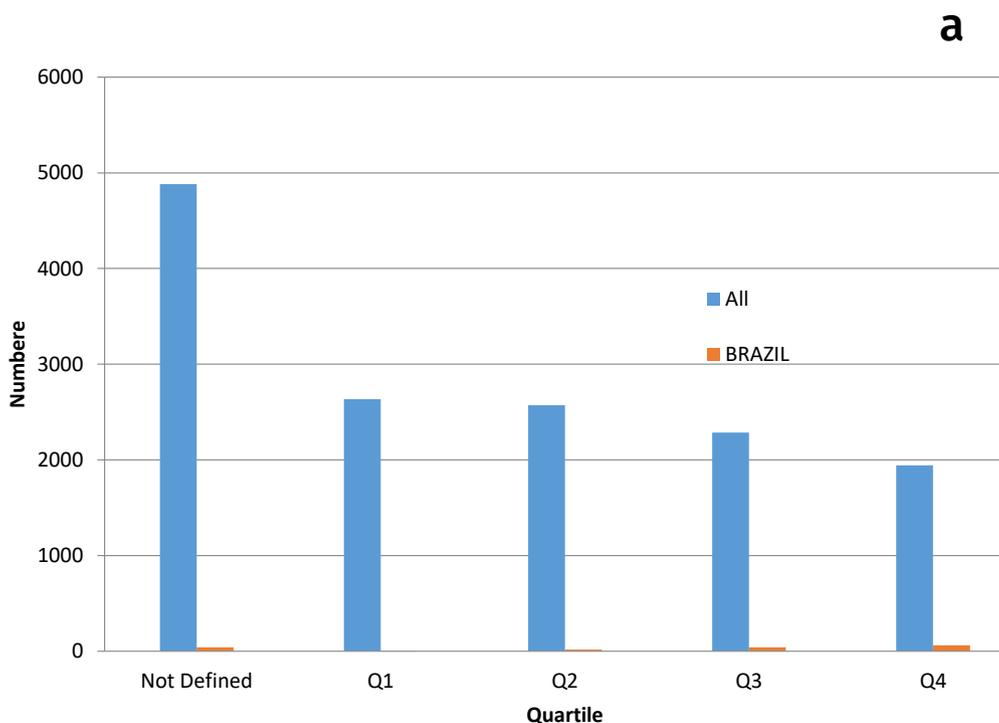


Figure 3. Distribution of journals (a) and Documents (b) by area of knowledge and journal quartile for publications from Brazilian Authors (Incites ® 2009-2019).

5), other areas have continued to rise or remain stable. This is not the case in journals outside these countries that have shown a decrease in most areas in recent years. See <https://www.scimagojr.com/journalrank.php> for a list of publishers and their country of origin.

Looking at CNCI and JNCI, while most vary significantly year to year, there has been a decrease in recent years, especially in CNCI. While there has been an increase in open access publishing in countries outside Brazil, Netherlands, England and the USA, the opposite has happened recently in these countries, as well a decrease in % of papers in top 10%. So, while Brazilian authors continue to publish in hybrid journals, they are more often opting for closed access. 89% of the papers published in Brazil are open access, compared with 21% of papers published abroad. The correlation between CNCI and % Open access documents in Q1 and Q2 journals, not counting Brazilian journals, was 0.52 ($P < 0.01$).

Looking at major publishers such as Elsevier (Figure 6), the peak occurred around 2012. There was a fall in OA publishing from 2013 to 2014 with a furthermore recent fall (from 2016/2017) in the % of open access papers in their journals by Brazilian Authors. This may be for three reasons: i) the global reaction to Plan S, so authors look for alternative journals to publish their works or ii) the costs of OA and the lack of funding to cover it in Brazil, iii) increase in the number of post-graduate courses in Brazil without an increase in budget. As all new courses up to 2019 received scholarships automatically from CAPES, this meant that the resources available for maintenance of the courses fell. The

Science without Borders program (McManus & Nobre 2017) used funding from the two major scientific agencies (CAPES & CNPq) to finance mainly undergraduate students in a period overseas. This meant that, for example, in 2015 and 2016, post-graduate courses lost 75% of their maintenance financing from CAPES, but not scholarships. Therefore, researchers prefer to publish in a better-qualified hybrid journal than a lower quality OA. This coincides with the recent fall in overall CNCI for the country.

In the last year (2019), a decrease in the number of papers has begun to appear in these journals. It is still too early to say if this is a trend or not, but without financing for science and laboratory maintenance Brazil will continually lose its capacity to compete at a world level, thereby making it more difficult for its researchers to publish OA in Q1 journals.

International collaboration in papers published in Brazil is around 8%, compared with 32% of those published abroad. This may also help Brazil maintain a reasonable level of publishing, as the research groups can capture resources abroad and these groups help to pay publishing costs. This collaboration, as well as collaboration with industry, varies depending on the area of knowledge (Figure 7). As can be seen, international collaboration in the agricultural area falls well below the other areas and may influence impact in these publications. International and industry collaboration publications have stagnated or have fallen in recent years, which may also explain in part the fall in impact.

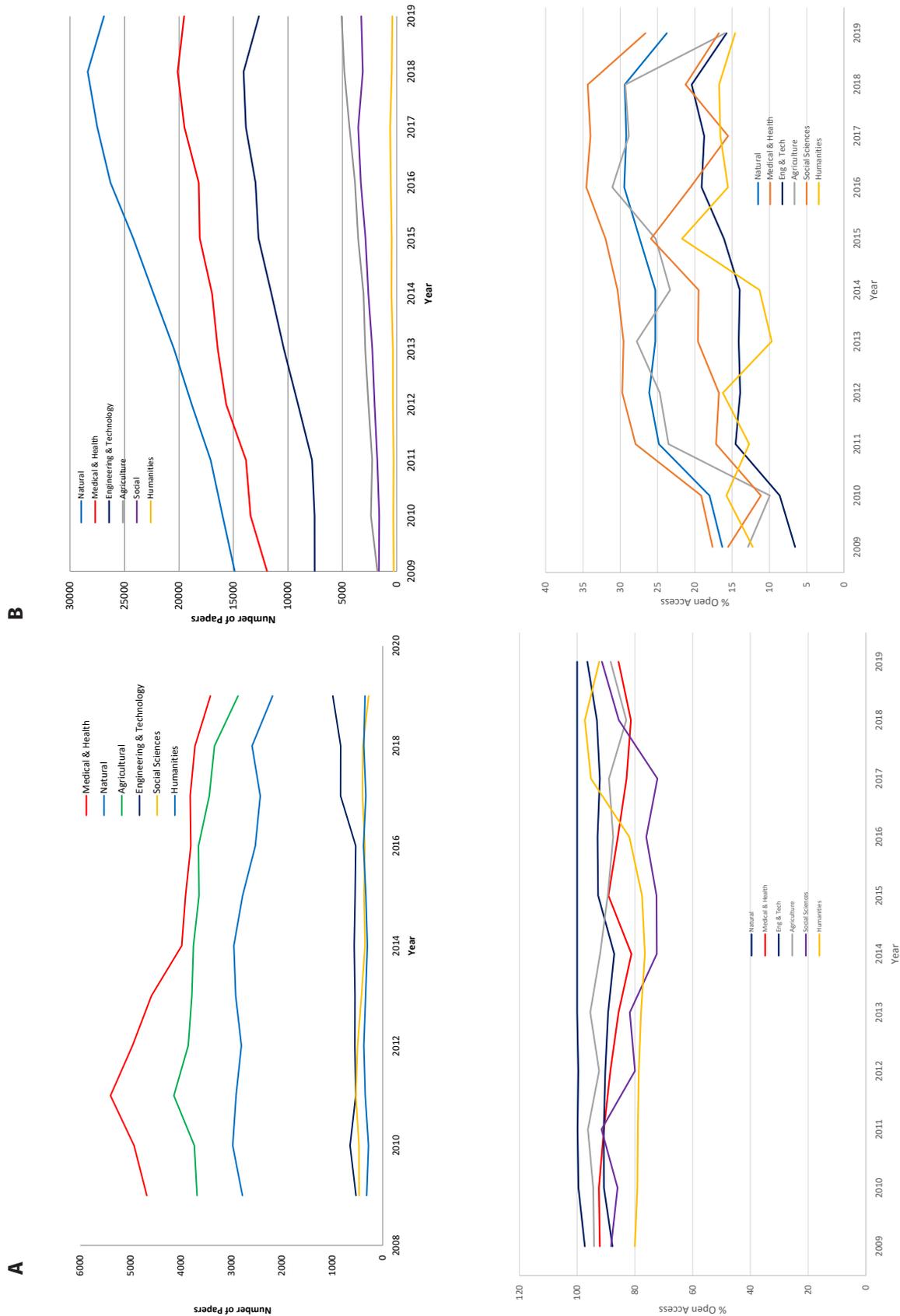


Figure 4. Numbers and impact of publications in Brazil (Column A) and abroad (Column B) by Brazilian authors (Incites® 2009 – 2019).

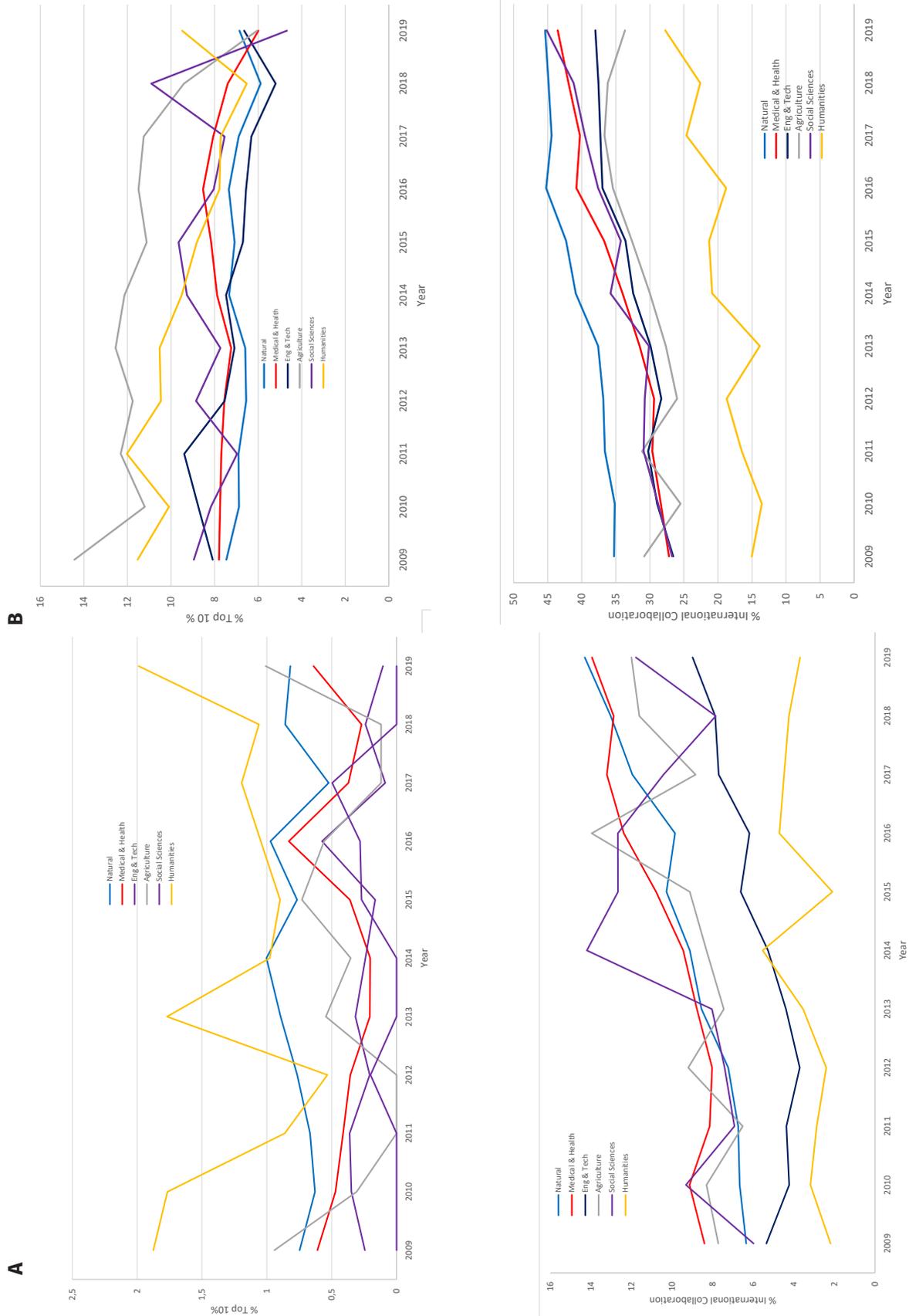


Figure 4. Numbers and impact of publications in Brazil (Column A) and abroad (Column B) by Brazilian authors (Incites © 2009 – 2019).

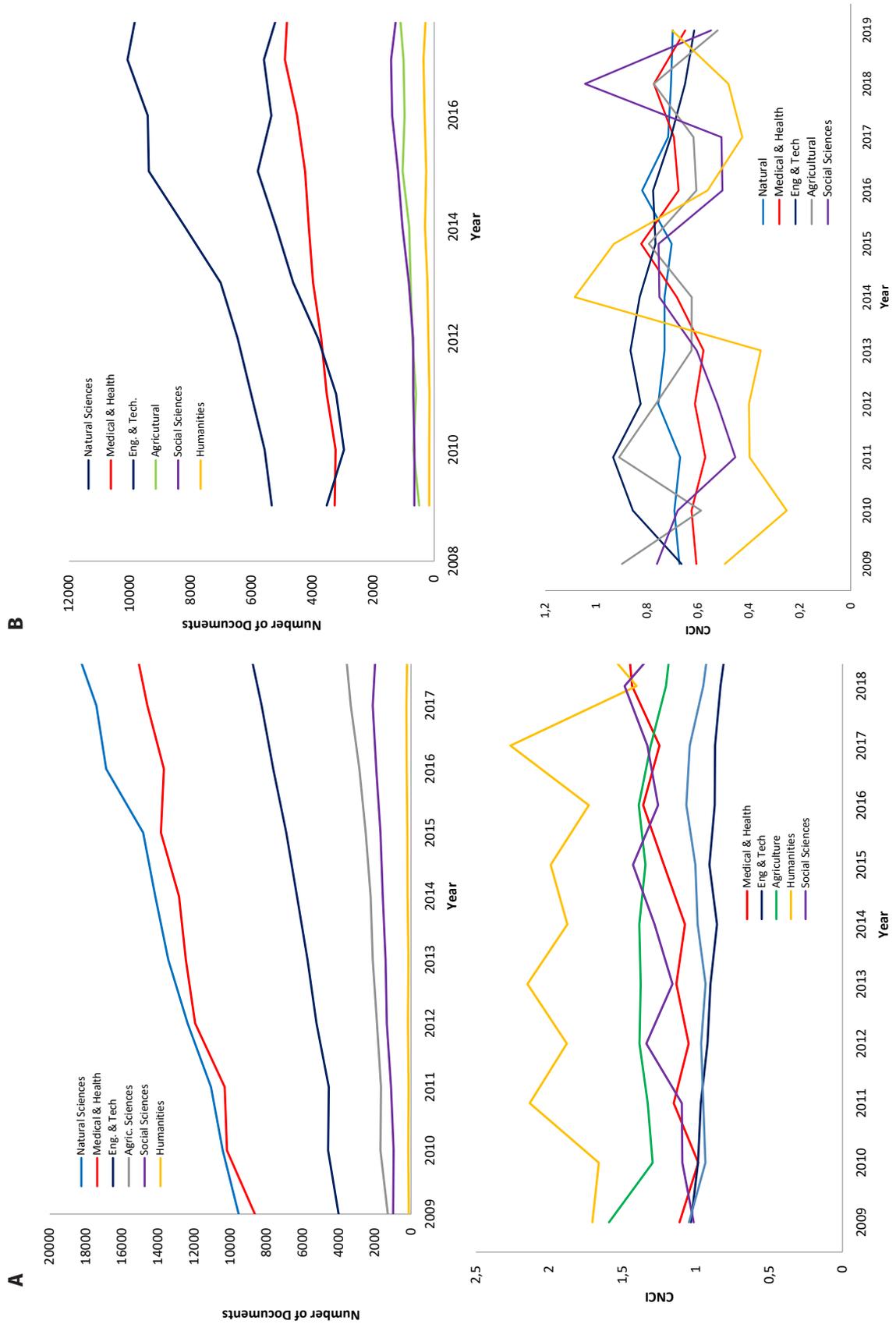


Figure 5. Impact of Brazilian publications by major publishing countries (Column A) and others (Column B) (Incites® 2009 – 2019).

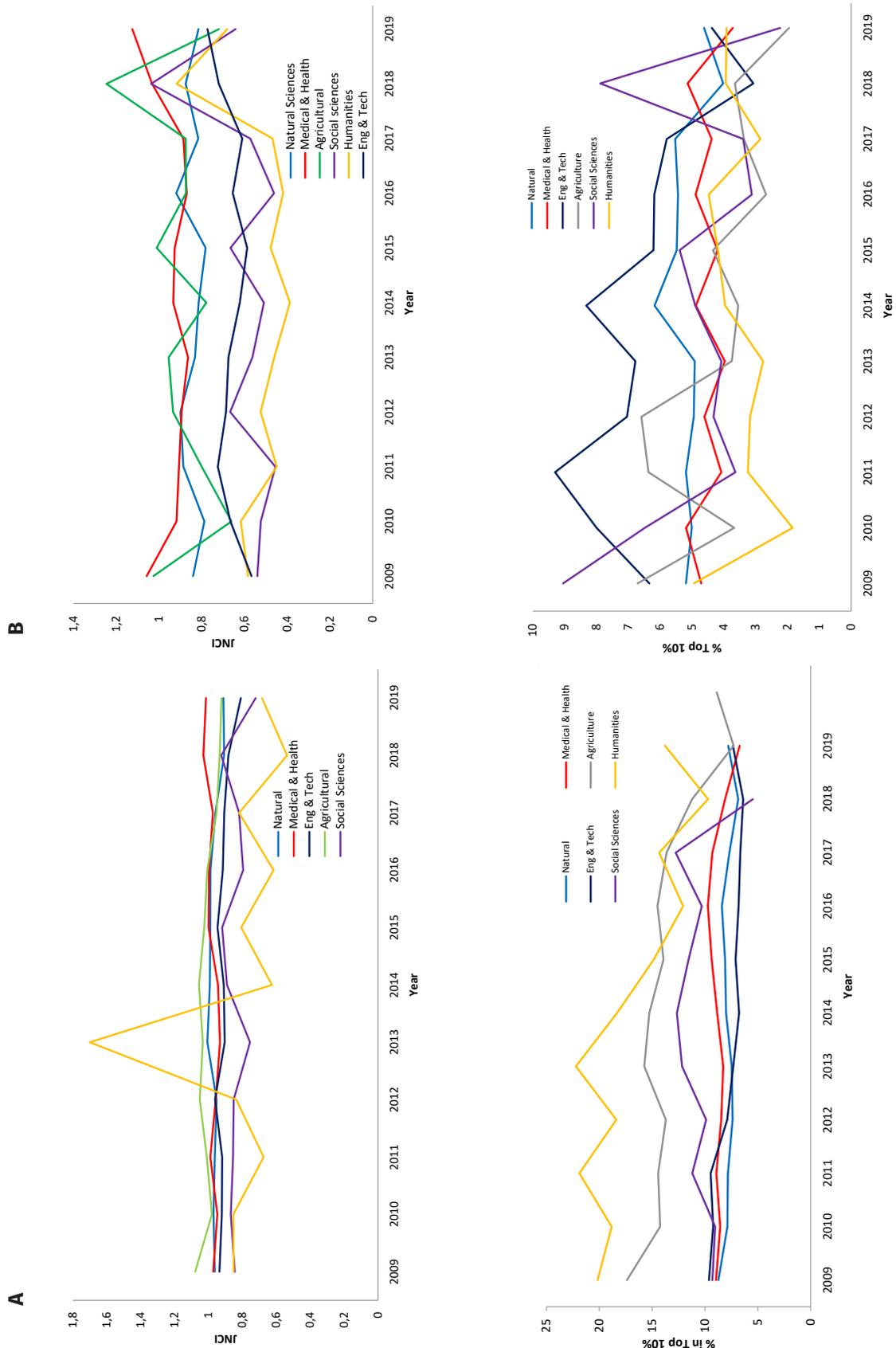


Figure 5. Impact of Brazilian publications by major publishing countries (Column A) and others (Column B) (Incites © 2009 – 2019).

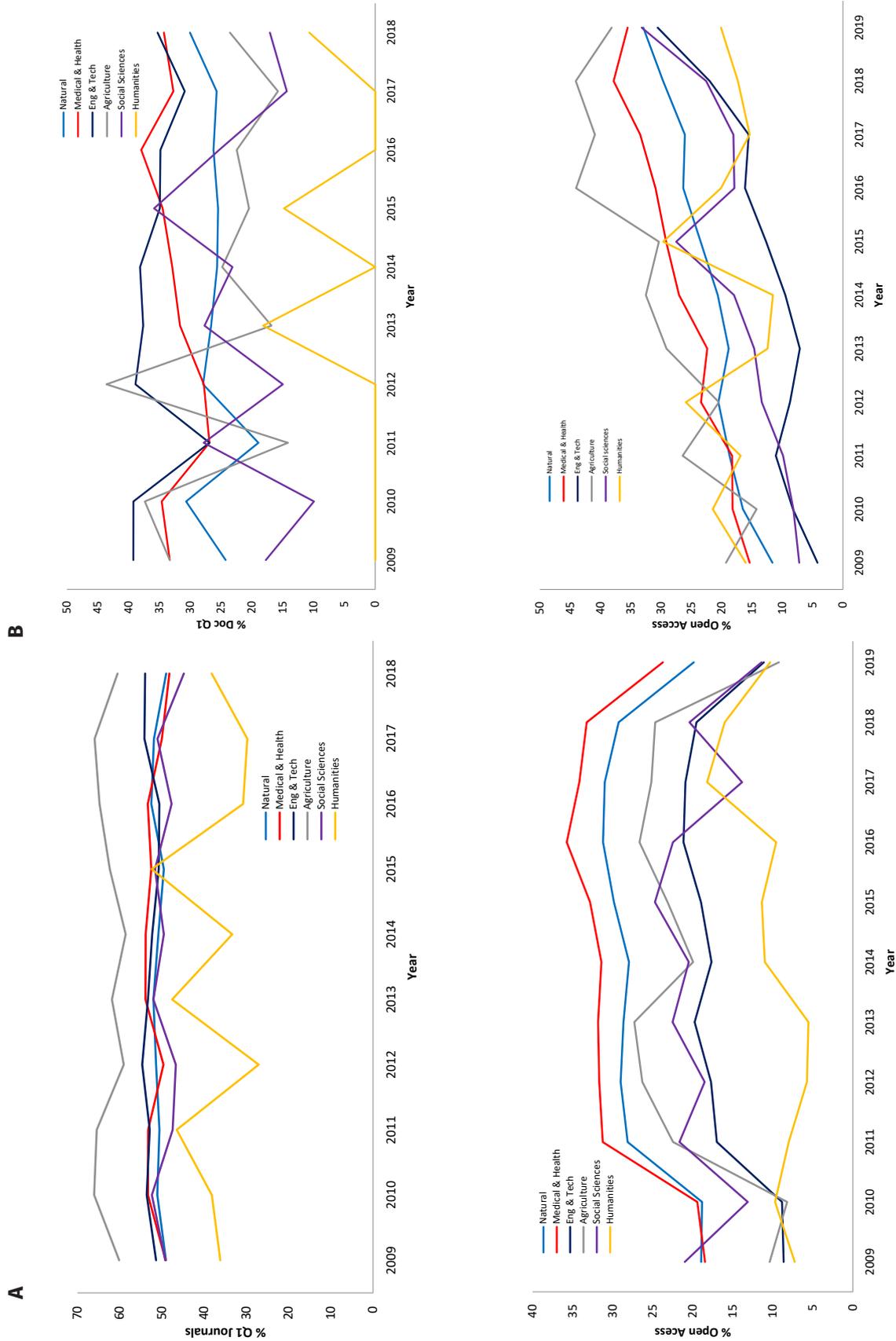


Figure 5. Impact of Brazilian publications by major publishing countries (Column A) and others (Column B) (Incites © 2009 – 2019).

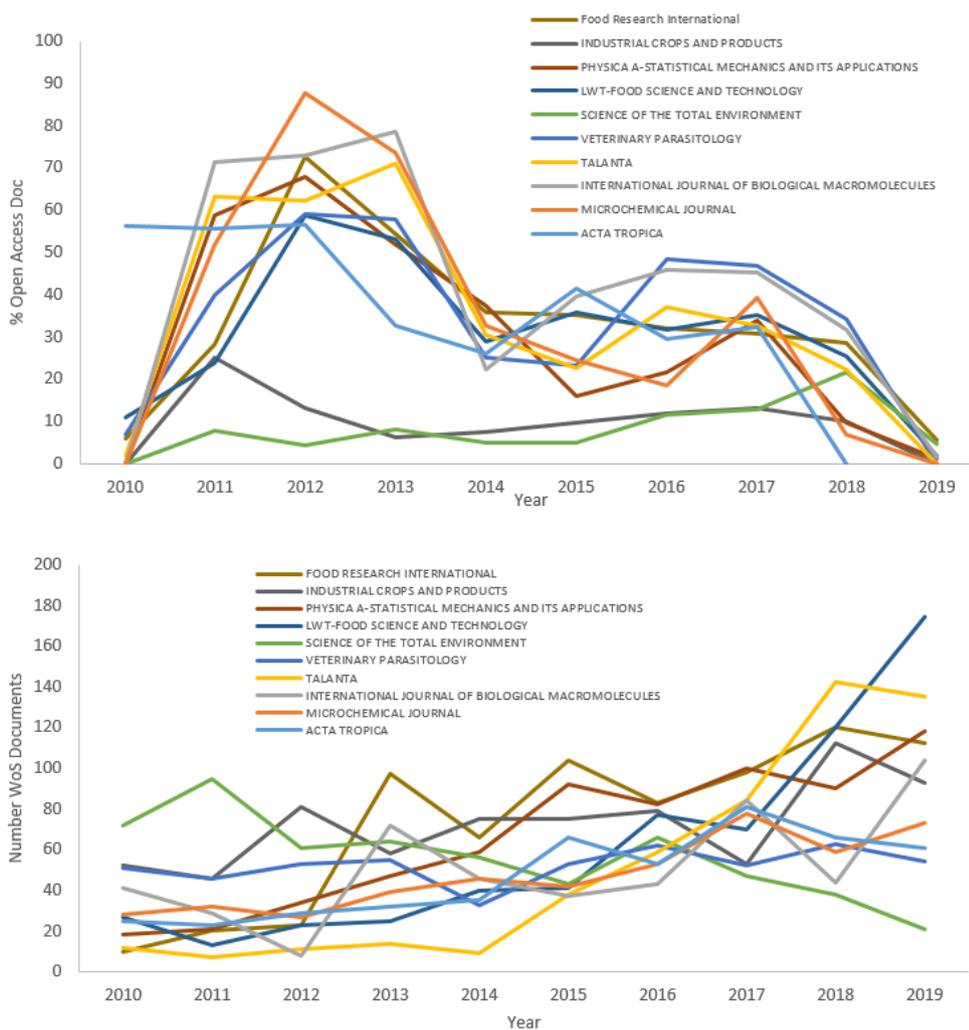


Figure 6. Percentage Open Access (a) and Number of Web of Science (WoS) Documents (b) in main Elsevier journals where Brazilian authors publish (Incites® 2010-2019).

Cost of Publishing

The cost of publishing in the timeframe of this study was USD 37 million in these 50 journals (Table II). Only the Brazilian journals had a processing charge, while mainly the health journals were free. Two international journals were members of SCOAP3 (scoap3.org). Where open access was not obligatory, the Brazilian authors tended to publish closed access. Of this, USD 3,959,260 was for translation costs, USD 639,887.5 for submission costs and USD 32,417,620 for Article Processing Charges (APC). APC for Brazilian journals was normally less than for foreign journals, but these also have a lower impact. Only Brazilian journals

covered a submission charge. Some of these also accepted papers in Portuguese or Spanish as well as English, while only one accepted papers in French.

The price of publishing a paper in a Brazilian journal was approximately USD 250 compared with USD 840 abroad. This may, in part, explain the movement away from traditional publishers as financing for this part of the scientific process may be financed by the pool of authors from their own pockets. If we take the other 350,000 papers at 50% of this cost (cheaper journals, less translation), the total would be approximately a further USD 80,578,382. This means Brazil/Brazilian authors

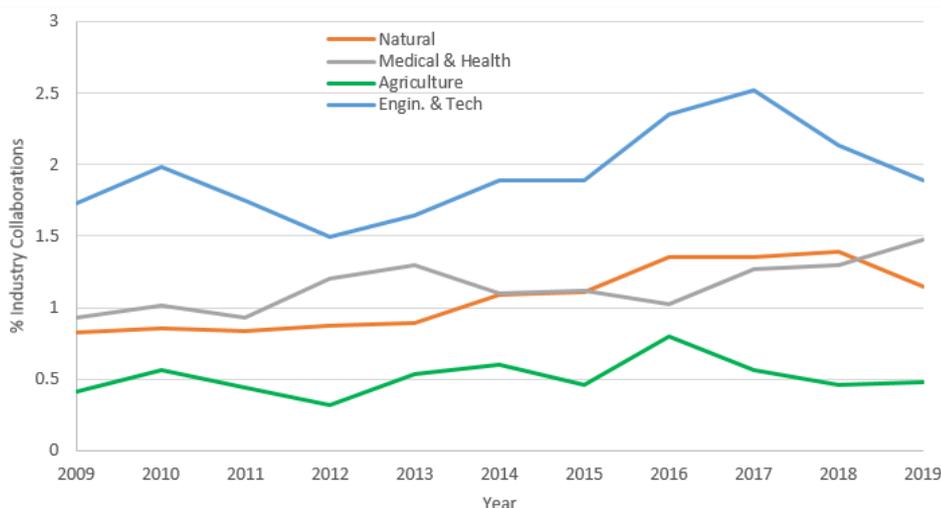
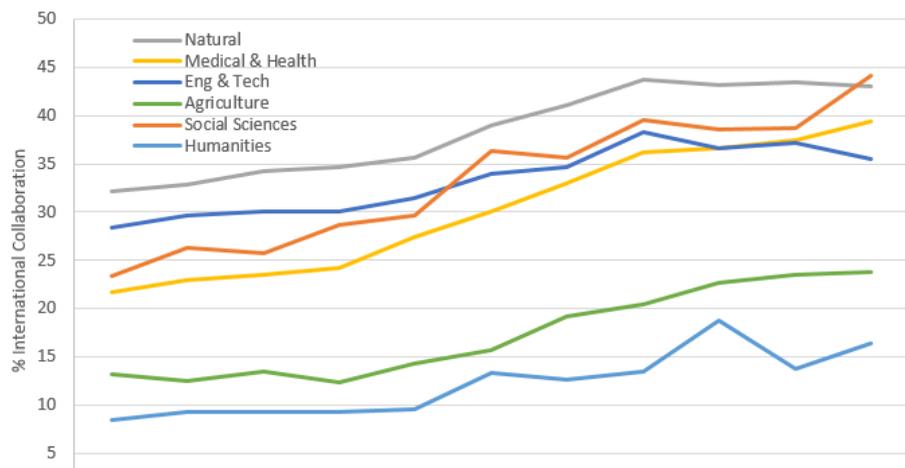


Figure 7. % Industry (a) and overall international collaboration (b).



pay approximately USD 11 million per year just to publish their studies. This does not take into account manuscript rejection and resubmission where Hall and Wilcox (2007) concluded that 62% of the published papers have been rejected at least once with a higher rejection rate in better quality journals (Wager 2005, Aarssen et al. 2008). The average cost per article was USD 470, and per citation was USD 71. The cost per citation in the Brazilian journals was USD 76.10 with 3.84 citations per article while abroad it was USD 58.71 per citation and 16.46 citations per article. The correlation between the cost of publishing and the number of citations was

positive and significant (0.54). Unfavourable changes in currency change rates will negatively affect this situation. Here we used BRL\$4.3 per USD.

Statistical Analyses

Journal Impact Factor has a close relationship with Article influence, Immediacy Index, 5 yr Impact factor and CNCI (Figure 8), but this has little relationship with % Open Access documents. This may be because almost all journals in Brazil are OA but have low citation indices, while abroad the situation is different.

Table II. Publishing costs (USD) for the top 50 Journals where Brazilian authors publish (1USD = BR\$4.3).

Journal	Number	Language ¹	Translation ³	Submission	APC ²	Country	% Open Access	Total
PLOS One	6306	E	219976.70		10058070.0	USA	100	10278047
Ciência Rural	3215	Preferably E, P	62804.65	74767.44	628046.50	Brazil	100	765618.6
Ciência & Saúde Coletiva	3199	P, S, F or E	27898.26			Brazil	100	27898.26
Zootaxa	3074	E	107232.6			New Zealand	3.45	107232.6
Semina- Ciências Agrárias	2993	P, E	52203.49	69604.65	208814.00	Brazil	100	330622.1
Arquivo Brasileiro de Medicina Veterinária e Zootecnia	2365	E	82500.00	33000.00	577500.00	Brazil	100	693000
Physical Review D	2279	E	79500.00		2727500.00	USA	47.87	2807000
Pesquisa Veterinária Brasileira	2085	E (cert)	654593.00			Brazil	100	654593
Scientific Reports	2062	E	71930.23		3082690.00	England	100	3154620
Cadernos de Saúde Pública	1988	P, S, or E	22885.12			Brazil	100	22885.12
Journal of the Brazilian Chemical Society	1964	E (cert)	616604.7		397367.40	Brazil	100	1013972
Química nova	1897	P, E, S	21837.56		251462.80	Brazil	100	273300.3
Bioscience Journal	1759	E	61360.47		114539.50	Brazil	13.42	175900
Revista Brasileira de Engenharia Agrícola e Ambiental	1691	E	58988.37	78651.16	314604.70	Brazil	100	452244.2
Pesquisa Agropecuária Brasileira	1662	E	57976.74			Brazil	100	57976.74
Brazilian Journal of Animal Science	1562	E	54488.37	19252.56	406846.50	Brazil	100	480587.4
Anais da Academia Brasileira de Ciências	1561	E	54453.49			Brazil	100	54453.49
Materials Research-Ibero-American Journal of Materials	1419	E	49500.00		264000.00	Brazil	100	313500
Revista Brasileira de Ciência do Solo	1372	E (rec)	239302.30		255255.80	Brazil	100	494558.1
Revista da Escola de Enfermagem da USP	1366	P, E, or S	15867.84		683000.00	Brazil	100	698867.8
Revista da Sociedade Brasileira de Medicina Tropical	1351	E (cert)	424151.2			Brazil	100	424151.2
Revista Brasileira de Fruticultura	1335	P, S or E	46569.77	46569.77	248372.10	Brazil	100	341511.6
IEEE Latin America Transactions	1323	S or P	46151.16			USA	1.97	46151.16
Genetics and Molecular Research	1287	E	44895.35	149651.20	299302.30	Brazil	99.07	493848.9

Table II. (continuation)

Journal	Number	Language ¹	Translation ³	Submission	APC ²	Country	% Open Access	Total
Anais Brasileiros de Dermatologia	1255	E	43779.07			Brazil	100	43779.07
Physical Review B	1251	E	43639.53		1065000.00	USA	34.05	1108640
Monthly Notices of the Royal Astronomical Society	1221	E	42593.02			England	66.83	42593.02
Arquivos Brasileiros de Cardiologia	1208	E or P	21069.77			Brazil	100	21069.77
Brazilian Journal of Biology	1198	E	41790.70			Brazil	100	41790.7
Journal of High Energy Physics	1188	E	41441.86			Italy	91.08	41441.86
Clinics	1171	E	40848.84		1990700.00	Brazil	100	2031549
Revista Latino-Americana de Enfermagem	1161	P, E or S	13486.50		81000.00	Brazil	100	94486.5
Arquivos de Neuro-Psiquiatria	1138	E	39697.67			Brazil	100	39697.67
Engenharia Agrícola	1129	E, P or S	13126.59	31506.98	39383.72	Brazil	99.56	84017.29
Revista de Saúde Pública	1096	P, S, or E	12731.44		611720.90	Brazil	100	624452.4
Physical Review E	1081	E	37709.30		585000.00	USA	21.65	622709.3
Memorias do Instituto Oswaldo Cruz	1039	E	36244.19			Brazil	100	36244.19
Physics Letters B	1037	E	36174.42			Netherlands	94.31	36174.42
Revista Caatinga	1026	E P	17895.35	35790.70	513000.00	Brazil	100	566686
Phytotaxa	1022	E	35651.16		12460.00	New Zealand	8.71	48111.16
Revista Ciência Agronômica	1008	P, E or S	11709.21	23441.86		Brazil	100	35151.07
Ciência Florestal	1005	P, E or S	11674.36		150750.00	Brazil	100	162424.4
Revista Arvore	991	E	34569.77		115232.60	Brazil	100	149802.3
Acta Cirúrgica brasileira	959	E	33453.49		334534.90	Brazil	100	367988.4
Physical Review Letters	954	E	33279.07		2352000.00	USA	70.44	2385279
Acta Paulista de Enfermagem	954	P or E	16639.53	77651.16	354976.70	Brazil	100	449267.4
Biota Neotropica	938	E	32720.93		218139.50	Brazil	98.19	250860.5
Food Chemistry	919	E	32058.14		876400.00	England	34.06	908458.1
Physical Review A	899	E	31360.47		562500.00	USA	25.03	593860.5
Plos Neglected Tropical Diseases	867	E	30244.19		2037450.00	USA	100	2067694
Total	78830		3959260	490236.30	32417620			37016768

¹ E – English, P – Portuguese, S – Spanish, F – French, (cert) – must present translation certificate by professional; ²APC – Article Processing Cost; ³Normally 10% of the papers except when a certificate must be produced when 90% was used.

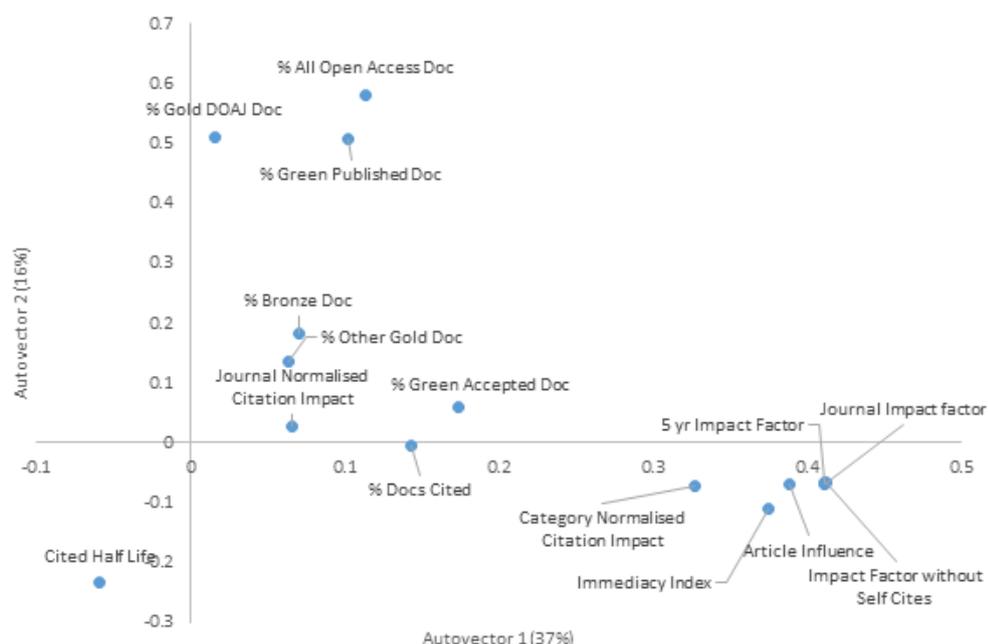


Figure 8. First two eigenvectors for journal traits for Brazilian publishing (definitions at https://clarivate.libguides.com/incites_ba/alpha-indicators).

Clusters 1 and 2 had the lowest quality indicators in general (Table III), especially related to impact factors. As can be seen, open access did not necessarily mean higher impact as cluster 2 had the highest % open access but some of the lowest impact. Most Brazilian papers are in cluster 2 (Table IV). It can also be seen that just because the journal is based in the USA or England this does not reflect quality.

DISCUSSION

According to Harnad et al. (2004), merely to do the research and not publish is no better than no research. Researchers must submit their research to peer review and publish so others can use and apply their findings. By using and citing these papers, other researchers show their value, but first they must be able to access them. The “*journal-affordability problem*” and the resulting journal budget crisis were what first brought the “*article-access/impact problem*” to light (Harnad et al. 2004). To overcome this, Brazil (CAPES) signed agreements with major

publishers to form a single scientific gateway (Almeida et al. 2010) that gives desktop access to major journals from most computers connected to university networks in Brazil. The university budget used to this end comes from the Ministry of Education and competes with postgraduate scholarships. To date, this access has been seen as a priority for the advance of Brazilian science.

Academic journals are atypical information goods. The publishers do not pay the provider of the primary good, scholarly papers, nor do they pay for quality control through peer review (Larivière et al. 2015). The open-access model is lauded as being the most appropriate, especially where research is financed by public funds (Carroll 2011), but the question is – who pays to publish? Financing restrictions have meant that OA is becoming more difficult for Brazilian authors, especially abroad, where charges are higher, as seen in this study. Despite having access to journals, Article Processing Charges (APC) are not paid by funding agencies in projects. Some universities offer limited funds for paying these charges, but otherwise, these

Table III. Cluster means for publication profiles of Brazilian authors (2010-2019).

Cluster	No. Journals	% Doc Cited	5 Yr Impact Factor	Article Influence	CNCI ¹	Cited Half-Life	Immediacy Index	Impact Factor w/o Self Cites	Journal Impact Factor	JNCI ²	% All Open Access	% Bronze	% DOAJ ³ Gold	% Green Published
1	11354	62.59	2.41	0.7	0.61	7.64	0.64	2.01	2.25	0.82	5.08	1.37	0.09	2.38
2	1286	68.45	2.68	0.79	0.73	5.32	0.48	2.3	2.49	0.96	99.43	0.56	98.45	53.78
3	426	61.30	3.36	1.19	0.85	7.28	0.83	2.88	3.09	0.75	97.52	58.75	0.64	70.08
4	813	85.18	3.77	1.39	1.31	7.55	1.02	3.35	3.61	1.12	75.65	63.18	1.21	15.42
5	437	81.53	5.72	2.22	1.78	7.29	1.52	5	5.28	1.04	81.17	3.24	0.5	23.91

¹CNCI – Category Normalised Citation Impact; ²JNCI – Journal Normalised Citation Impact; ³DOAJ – Directory of Open Access Journals.

funds come from the researcher’s pockets or productivity scholarships.

The trend of Brazilian authors towards closed access in journals from prestigious publishers was seen in this paper. Nevertheless, some of these journals offer the option for green access which is still low in Brazilian universities. Heavy investment favouring Gold over Green OA has been associated with increased total publication costs, inequality of opportunity to publish, and concerns about integrity in science reporting (James 2017). A study by Mueller-Langer & Watt (2018) showed that Hybrid Open Access journals (HOA) do not constitute a significant advantage in the competition for citations. Nevertheless, there is a correlation between APC price and quality, where quality is measured by citation rates (Björk and Solomon 2015, Pinfield et al. 2017), as also seen in this study.

When looking at OA, Gasparyan et al. (2016) saw that inexperienced authors from more challenging research environments, where quantity is more important rather than the quality of their publications, as well as their financing agencies should be blamed for prioritising any ‘international’ English publication regardless of the indexing and archiving prospects (so-called predatory journals). Large-scale bibliometric databases, which mainly cover journals published by commercial publishers, are used to count papers, which creates an incentive for researchers to publish in these journals (Larivière et al. 2015) and, thus, reinforces the control of commercial publishers on the scientific community. As publication pressure to publish abroad continues, it may be that the number of articles in predatory journals is also increasing and authors are unaware of journal quality. For example, the journal *Genetics and Molecular Research*, seen here among the top 50, appears on such a list (<https://predatoryjournals.com/journals/#G>) and is not indexed in the latest

Table IV. Number of papers and journals per cluster, country and quartile from Brazilian authors (InCites® 2010-2019).

Quartile Papers	Cluster					Total
	1	2	3	4	5	
Not Defined	12763	5404	1325	1580	697	21769
Q1	86822	13534	3023	12287	5355	121021
Q2	71447	27388	1493	6398	764	107490
Q3	51240	33399	893	4038	629	90199
Q4	28899	50661	906	2943	332	83741
Total	251171	130386	7640	27246	7777	424220
Country						
Number of papers	1	2	3	4	5	
USA	79644	13004	3492	10745	4846	111731
BRAZIL	7873	88623	704	2659	414	100273
ENGLAND	60619	10808	1499	7274	1264	81464
NETHERLANDS	40818	1479	149	2821	282	45549
GERMANY (FED REP)	17517	1667	139	296	57	19676
SWITZERLAND	6470	6834	72	279	49	13704
NEW ZEALAND	4175	317	0	1	7	4500
FRANCE	2579	249	2	1208	0	4038
DENMARK	3524	149	1	2	12	3688
ITALY	1478	1654	0	53	0	3185
Rest	26474	5602	1582	1908	846	36412
Total	251171	130386	7640	27246	7777	424220
Number of journals	1	2	3	4	5	Total
USA	3020	176	132	327	147	3802
ENGLAND	1991	312	64	168	79	2614
NETHERLANDS	848	28	14	51	26	967
GERMANY (FED REP)	560	54	15	19	7	655
SWITZERLAND	226	111	8	19	7	371
JAPAN	116	13	13	50	3	195
FRANCE	148	19	2	18	0	187
BRAZIL	25	126	3	8	3	165
CHINA MAINLAND	94	44	13	10	2	163
SPAIN	71	51	7	6	0	135
Rest	4255	352	155	137	163	5062
Total	11354	1286	426	813	437	14316

Q1 – 1st quartile; Q2 = 2nd quartile; Q3 – 3rd quartile, Q4 – 4th quartile.

JCR (Journal Citation Report). English language journals and Basic sciences journals have higher impact factors (Dewan & Shah 2016). In terms of rejection, *PLoS ONE* publishes 70% of submitted articles, whereas *Physical Review Letters* publishes fewer than 35% and *Nature* published just 8% in 2011 (Van Noorden 2013). It is also more likely that a university administrator in Brazil can be convinced to pay APCs to publish in *Nature* than in a medium impact, but still higher than world mean, OA journal in a specific area.

Indexing in international databases is difficult for regional and national journals, published in native languages (Dewan & Shah 2016) as not all research shows global relevance. Therefore, some papers may only be suited for publication in a regional or national journal that may not be indexed. Nevertheless, the bibliometric understanding of scientific impact is a multi-dimensional construct (Hall 2011). Supporting native languages in science, which may have specific research-related terminology, is important where dissemination and popularisation of scholarship in domestic languages are needed (Mathies et al. 2020). Comparing with this latter paper, social sciences and Humanities (SSH) impacts are higher than seen here but lower than the other disciplines. Sivertsen (2016) argues that SSH needs to be connected to national culture and society to maintain its reason to exist. McManus & Neves (2020) discuss these areas in Brazil further. At the same time, publishing at the international level is necessary to keep connected with international peers and wider scientific of the field. The challenge of publication language, therefore, is not about 'either-or', but it is about finding an appropriate balance in domestic and international (English-language) publishing efforts. Bornmann & Leydesdorff (2013) state that the increase of publications of a country in the English language contributes to an increase

in citation impact. As seen here, most of the Brazilian journals are published in English, or English and another language. As noted by Strehl et al. (2016), the role played by national journals in emerging countries is different from that in developed countries and helps in the developing skills at reporting and editing research results (Meneghini 2012). Nevertheless, authors may send their papers to national journals after rejection in international journals or because of perceived lower quality and therefore they suppose rejection is probable (Meneghini 2010).

Geographical distribution in agricultural sciences (Touzard et al. 2015) is seen using a bibliometric analysis of international journals. Van Leeuwen et al. (2001) pointed to language bias that may lead to underrating the scientific output of larger countries with non-English domestic journals. Countries such as Japan and Germany also show low citation impact in several areas such as Medical & Health and Agricultural Sciences, while Japan also shows low impact in Engineering & Technology and Natural Sciences (Bornmann & Leydesdorff 2013).

Publishing in collaboration with foreign partners is also well documented as affecting citation impact (Franceschet & Costanini 2010) but as seen here, this has begun to stagnate or fall. This is a warning light for Brazil and also may reflect that the scientific park in national universities has begun to become obsolete, making these collaborations more difficult. These collaborations also provide data, resources, equipment, and theories essential for the advance of science, especially in emerging economies. Studies show that an increase in funding for research is accompanied by an increase in the number of international publications (Quan et al. 2017) and that this is linked to an increase in quality.

There is evidence to show that more entrepreneurial opportunities are provided in

regions which are rich in knowledge (Audretsch et al. 2012), as geographic proximity is important in the process of knowledge spillovers (Varga, 2000). Growing expectations in universities as engines of regional innovativeness have led to the creation of new institutions and policies for strengthening university-industry-government linkages and their outcomes. The creation of Federal Institutes of Technology in Brazil, as well as the creation of the professional masters and doctorates in universities, were meant to meet this demand, but these are relatively recent. They shift towards the 'entrepreneurial university' that does not only contribute to regional but also to national and international innovation (Goldstein 2010) by translating academic research into commercial outputs as well as scientific research and teaching (Etzkowitz & Leydesdorff 2000). Nevertheless, the reduction in industrial collaboration seen here needs also to be monitored, as innovation requires basic research which has been falling in quantity and impact.

CONCLUSIONS

Several warning lights are beginning to appear in the Brazilian publication scenario such as stagnation of production, reductions in international and industry collaborations, move towards closed access publishing, unfavourable changes in currency exchange rates, among others. These data can be used to develop sustainable financing and developmental objectives for Brazilian science.

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SUPPLEMENTARY MATERIAL

Figure S1. Distribution of Journals (Column A) and Documents (Column B) by Journal country of origin for publications by Brazilian Authors in each Area of Knowledge (Incites® 2009-2019). (Brazilian journals are highlighted in each figure).

Figure S2. Distribution of Journals (Column A) and Documents (Column B) by Area of Knowledge and journal quartile for publications from Brazilian Authors (Incites® 2009-2019).

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