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Impact of Scientific Productivity and Trend on Publication Output of Nigerian Authors in Web of Science from 2006 to 2016

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Abstract

Citation is one of the most important instruments in analysing the impact of scientific productivity of researchers and research institutions. Citation is driven by scientific publication and substantially increases by collaboration. This study aims at assessing the trend in publication output and the impact of scientific productivity in Nigeria. The results reveal that publication output has continued to increase moderately with a mixed growth pattern. Most institutions recorded an irregular rise and fall in their publication output. This fluctuation has led to weak and moderate monotonic trend in their publication output. The results also reveal that citation is highly associated with the number of publications and collaborations.

Keywords: Scientific productivity, Nigerian authors, Citations, Collaboration, Web of Science

Introduction

The recognition and advancement of researchers rest greatly on the quantity and quality of the output of their scientific productivity (Yusuf, 2012). Scientific productivity is the foundation of the techniques that boost researchers ranking and rating (Denise and Isabel, 2016). Thomaz et al. (2011) noted that impact of scientific productivity is measured by researcher's citation count. Citation has been a favoured measure for the assessment of scientific productivity. Citation refers to a measure of "impact" or "utilisation" or "influence" of an article, researcher, and institution. Bornmann and Marx (2014) explained that citation measures the impact of publication. Martin and Irvine (1983) describe citation as the actual influence of a publication on the surrounding research activities. Also, Nieminen et al. (2006) describe citation as a measure of the utilisation and contribution of the published article. Citation allows for the quantification and measurement of the impact of scientific productivity of individuals, journals, researchers and institutions (Hurley et al., 2013). Das (2015) explained citation as the predominant method for measuring the impact of scientific publications for researchers and institutions. Citations help in identifying the role of highly cited papers in expanding the universe of knowledge, the formation of new scientific disciplines and strengthening scientific communities. Citation is driven by scientific publication and substantial increases by collaboration (Bosquest and Combes 2013).

Scientific publications are the tangible output of academic dissertations, research reports, monographs, conference papers, books, journal articles, and book chapters that appear in peer-referenced journals indexed by reputable agencies (Ynalvez, and Shrum, 2011). Scientific publications are channels through which researchers contribute their quota to existing body of knowledge by disseminating their research findings as a necessary act of informing and expanding knowledge in any discipline or field of study (Sarah, 2015). These publications help in sustaining the development of new ideas and knowledge that contribute ultimately to the growth of a discipline by employing the best

practices and theories in problem-solving and decision-making (Winston and Williams, 2003). Studies have shown that publication and citation are primary parameters used in the assessment of scientific activity and productivity of researchers and institutions (Huang, 2016; Abramo et al, 2014; Noruzi and Abdekhoda, 2014; Van Raan, 2008). Bornmann and Daniel (2009) explained that the relationship between publications and citations could measure scientific productivity. Similarly, Russell and Rousseau (2010) explained that publication and citation are generally used for assessing and measuring the scientific productivity of researchers and research institutions. Donaldson and Cookie (2013) explained that impact of scientific productivity incorporates elements of both publications and citation. They noted that to yield an "impactful" research and advance scientific knowledge, researchers must rely on networking and scientific collaborations. Scientific collaboration has a role in determining publications and citations.

Scientific collaboration is a form of interaction among researchers, allowing for effective communication, and working together to generate and report their research findings by sharing ideas, expertise, and resources (Ynalvez, and Shrum, 2011). Denise and Isabel, (2016) define scientific collaboration as the working together of researchers to achieve the common goal of producing new scientific knowledge.

Scientific collaborations are necessary for progress in academic research. Collaboration generally leads to an increase in citation. Aldieri et al. (2017) noted that collaborative research usually receives a higher number of citations than single-authored papers. O'Leary et al. (2015) explained that academic departments with greater collaboration had the highest level of citations. Fu et al. (2012) explained that research with a high level of international collaborations is highly cited. Chuang and Ho (2015) explained that international collaborated research publications produced higher citation rates.

Literature Review

A number of studies have examined research productivity in Nigeria. Most have concentrated on a particular subject area or/and region in Nigeria. Few of the studies employed bibliometric approach while others adopted a descriptive survey design. Using bibliometric analysis, Ani and Onyancha (2012) evaluated the research performance and productivity in Nigerian universities from 2000 to 2010. They noted that Nigerian researchers preferred publishing in foreign journals as opposed to regionally published journals. Their findings indicate that there is a significant level of growth in research and publication output in Nigeria in general, and in Nigerian universities in particular. Similarly, Ani et al. (2017) used bibliometrics to examine patterns of publication output in library and information science (LIS) research in Nigerian universities from 2000 to 2014. The findings show that there is no consistent or significant growth in publication in LIS research in Nigeria. Nwagwu (2006) tested the validity of Lotka's Law on four author categories of the biomedical research in Nigeria published in Medline for the period 1967 - 2002. The result shows that only the 'co-author' category differed from the inverse power version of the law. The categories of 'all authors', 'first authors', 'non-collaborative authors' did fit the Lotka's inverse power law with different parameters. Kpolovie and Onoshagbegbe (2017) examined the research productivity of academic staff of Nigerian universities. Research productivity was measured using Google Scholar h-index and i10-index. The findings revealed a statistically significant difference in h-index and i10-index.

Using survey data, Agboola and Oduwole (2005) investigated the effect of staff seminars on the publications productivity of library and information science (LIS) professionals in academic libraries in Ogun State, Nigeria. Their findings show that seminars have positively influenced the publication outputs of LIS professionals. Similarly, Okafor and Dike (2010) analysed the research output of academics in the science and engineering faculties of Federal government-owned universities in Southern Nigeria using survey data. Their results show that the academics published more in local journals than in overseas journals. Okiki (2013) assessed the level of research productivity of academic staff in Nigerian federal universities. The study adopted a descriptive survey design. The findings of the study show that socio-demographic variables have significantly contributed to the research productivity of the academic staff at federal

universities in Nigeria. The finding also reveals that financial constraint and slow Internet connectivity were major inhibitors to their research activities. Oduwole and Ikhizama (2007) examined the research output of librarians in Nigerian agricultural research institutes using survey data. They found that the librarians' research output, although generally low, was related to their work experience. Sarah (2015) reports the publication output of librarians in public universities in Southwest, Nigeria. The descriptive survey method was used for the study. They reported that librarians published more in international journals than local journals. They also identified time constraints, poor interpretation skills, and exorbitant publication fees by journal outfits, and indiscriminate rejection of manuscripts by journals as challenges to publication efforts. Findings indicate that the publication output of librarians between 2009 and 2014 was relatively high. Okiki and Mabawonku (2013) examined the influence of information literacy skills on academics research productivity in federal universities in Nigeria. Their findings show that academics possessed high information literacy skills and these had greatly influenced their research productivity. Ogbogu (2009) examined the research productivity of female academics in Nigerian universities. He stated that female academics made contributions that are more significant to teaching than research. The findings show that marital status, religion, academic position and the number of hours of lectures per week had an impact on research productivity. Using Ex post facto design, Usang et al. (2007) examined the research productivity of academic staff in South-South universities of Nigeria. The findings indicates that gender, marital status, and area of specialisation of an academic staff have a great influence on their research productivity. Isola et al. (2011) carried out quantitative analyses of researchers' productivity using partial productivity approach and an assessment of factors influencing research productivity. Findings from the study indicate that qualifications of researchers, years of experience, research collaborations, and time spent on research significantly contribute to research productivity.

Purpose of the Study

This study attempts to answer the following research questions:

- What is the trend in publication output in Nigeria?
- What is the trend in publication output of Nigerian institutions?
- What is the publication output per research area in Nigeria?
- What is the impact of their scientific productivity?

Methodology

Given that there is no citation database in Nigeria, this study opted to use the Web of Science database as the source of data. Web of Science is the oldest citation database; it has strong coverage with citation data and bibliographic data, which goes back to 1900. The Web of Science includes over 10,000 journals and comprises of seven different citation databases, including different information collected from journals, conferences, reports, books and book series (Boyle and Sherman, 2006).

Publications with an address from "Nigeria" for the period of 2006 to 2016 were identified. The document type was limited to "Articles". Thereafter, total annual publications, annual publications for prolific institutions, and publications per research area were retrieved. Data were also retrieved for prolific authors who have published at least 50 articles in the study period. Data retrieved for each author include the affiliated institution, total publications, total citations, author collaboration, and country collaboration. Author collaboration was determined by the number of persons that have co-authored an article at least once. Country collaboration was counted based on countries where the co-authors' institutions are located. A country is counted once irrespective of the number of authors from that country. For example, if an author has co-authored with seven authors, four from Canada, one from Ghana and two from Austria, the number of country collaboration is counted as three.

Mann-Kendell test was used to analyse the trend in publication output in Nigeria and Nigerian institutions. Mann Kendell test is widely employed to assess if there is a monotonic upward or downward trend of the variable of interest over time. It tests whether to reject the null hypothesis (H_0) and accept the alternative hypothesis (H_a), where:

- The null hypothesis (H_0) indicates that there is no monotonic trend
- The alternative hypothesis (H_a) indicates that a trend exists. This trend can be upward or downward.

By running a Mann-Kendall test at 95 confidence level with a significance level of (α = 0.05), p-value and Kendall's tau can be obtained. For p-value greater or equal to the significance level (α = 0.05), H_0 is accepted. Accepting H_0 indicates that there is no monotonic trend in publication output. On the other hand, for p-values less than the significance level α = 0.05, H_0 is rejected and H_a is accepted. Accepting Ha indicates that there is a significant trend in publication output. Kendall's tau, however, takes values between minus one and plus one, the closer tau is to ±1, the stronger the trend. A positive tau indicates an upward trend and a negative tau indicates a downward trend.

To determine the relationships between the citation in terms of collaborations and publications, correlation analysis was conducted. Correlation coefficient *r* measures the strength and the direction of a linear relationship between two variables. *r* usually takes values between minus one and plus one. The closer *r* is to ±1, the stronger the relationship between the measuring variables.

Linear regression was conducted to measure the strength of the association between citations and collaborations, and citations and publications. By running the regression test coefficient of determination (r^2), standardised residual and p-value can be obtained. The coefficient of determination (r^2) represents the per cent of the data that is the closest to the line of best fit. The closer r^2 to one, the better the regression line fits the data. P-values < 0.05 shows that the result is statistically significant.

Findings of the Study

The findings of the study are presented below.

What is the trend in publications output in Nigeria?

The total articles published during the study period was 22,945. Figure 1 reveals an increase in publication output from 2006, with a decrease in 2010 through 2013; however, there was an increase again between 2013 and 2016. This indicates a mixed growth pattern in the publication output in Nigeria.

The results of the Mann-Kendall test on trends in

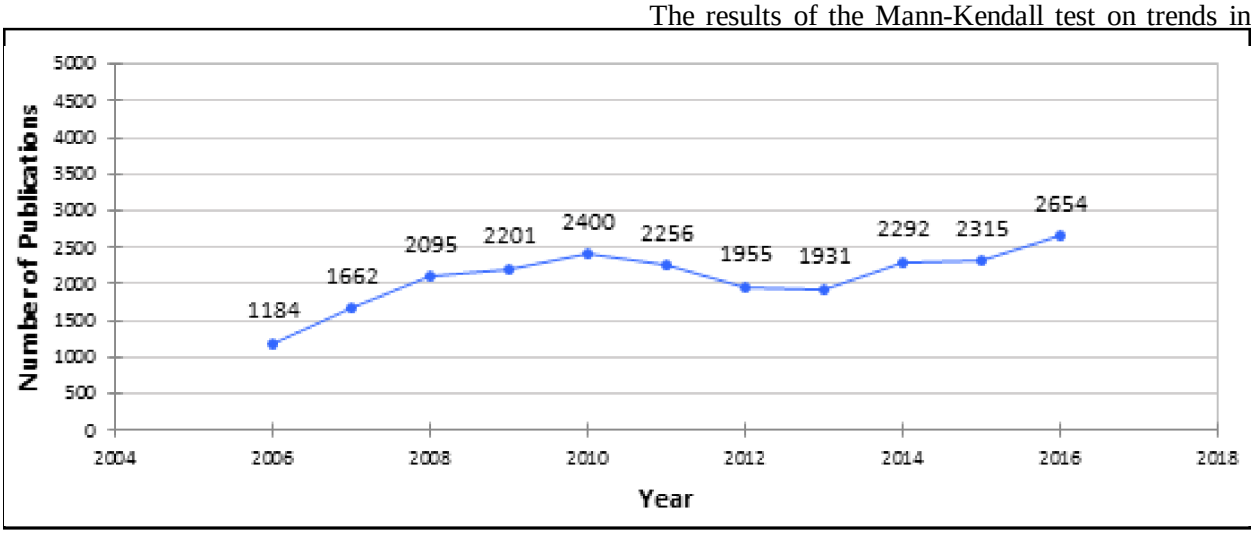


Figure 1: Trends in publication output in Nigeria, 2006 to 2016

publication output in Nigeria is given in Table 1. The results indicate that p-value is less than the significance level ($\alpha = 0.05$), therefore H_0 is rejected and H_a is accepted. Accepting H_a indicates that there is a significant trend in publication output. Kendell tau, however, reveals an upward and moderate trend in the publication output. This implies a moderate growth in publication output.

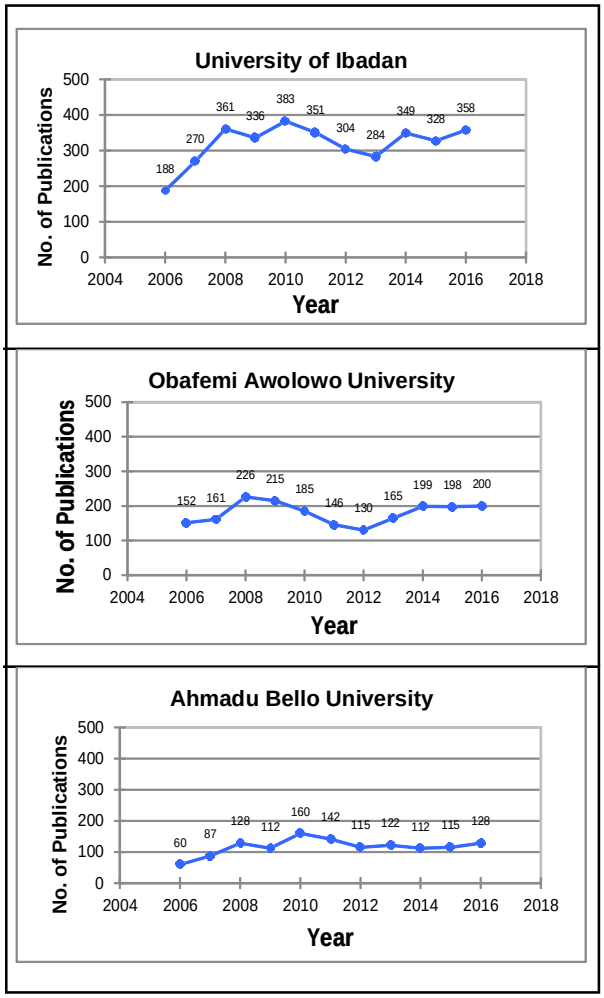
The results of the Mann-Kendall test on trends of

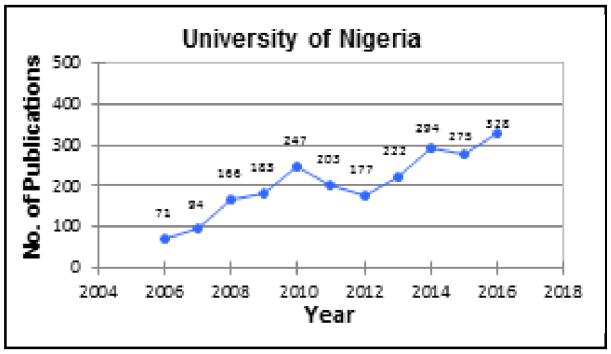
Table 1: Mann-Kendall test for trends in publication output in Nigeria

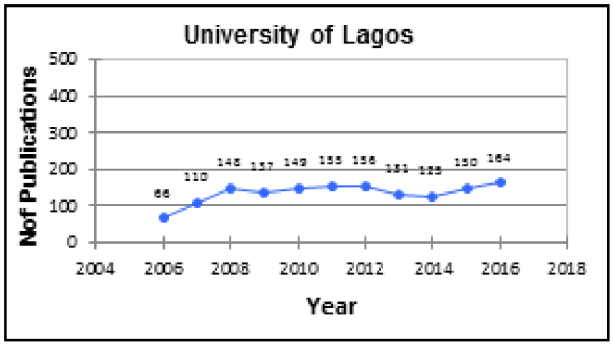
Year	Total Publications	Kendall's Tau	p-value	Test Interpretation
2006 - 2016	22,945	0.564	0.008	Trends exist with moderate growth

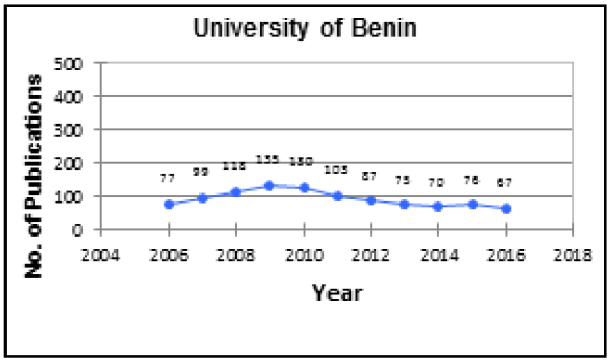
What is the Trend in Publication Output of Nigerian Institutions?

Figure 2 reveals that the publication output of the institutions has continued to increase with a mixed growth pattern. Most of the institution recorded an irregular rise and fall in their publication output. This indicates fluctuation in the publication output of Nigerian institutions.









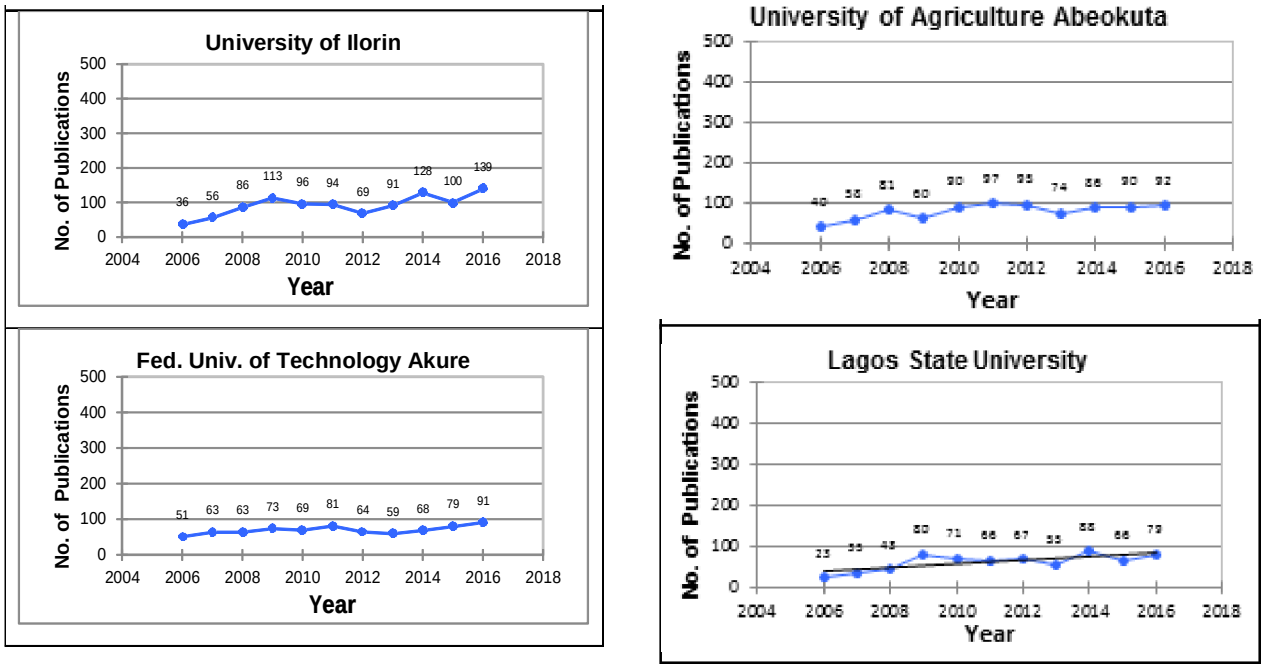


Figure 2: Trends in publication output of top 10 institutions, 2006 to 2016.

publication output of the top 10 institutions are given in Table 2. The results reveal that there is no monotonic trend in publication output of the University of Ibadan, Obafemi Awolowo University, Ahmadu Bello University, and the University of Benin. However, the results reveal a strong growth in publication output of the University of Nigeria, a moderate growth in publication output of the University of Ilorin and the University of Agriculture Abeokuta, and a weak growth in publication output of the University of Lagos, the Federal University of Technology Akure and Lagos State University. Figure 3 shows the regression model for citation by

Table 2: Mann-Kendall test for trends in publication output of top 10 institutions

Publishing Institutions	Total Publications	Kendall's tau	p-value	Test Interpretation
University of Ibadan	3512	0.200	0.196	No monotonic Trend
University of Nigeria	2260	0.782	**0.000**	Trends exist with strong growth
Obafemi Awolowo University	1977	0.127	0.230	No monotonic Trend
University of Lagos	1491	0.491	**0.018**	Trends exist with weak growth
Ahmadu Bello University	1281	0.262	0.101	No monotonic Trend
University of Benin	1037	-0.491	0.982	No monotonic Trend
University of Ilorin	1008	0.564	**0.008**	Trends exist with moderate growth
University of Agriculture Abeokuta	863	0.514	**0.014**	Trends exist with moderate growth
Fed Univ. Technology Akure	761	0.477	**0.021**	Trends exist with weak growth
Lagos State University	673	0.440	**0.030**	Trends exist with weak growth

What is the Publication Output per Subject Area in Nigeria?

Table 3 shows the publication output per subject area in Nigeria. Medicine General Internal is the most research field in Nigeria. It is obvious from the results medical, health, technology and sciences dominate the top 10 fields of research in Nigeria.

Table 3: Publication output per subject area, 2006-2016

WOS categories	Total Publications	Percentage
Medicine General Internal	1582	6.90
Public Environmental Occupational Health	1541	6.72
Biotechnology Applied Microbiology	1519	6.62
Environmental Sciences	1270	5.54
Food Science Technology	1214	5.28
Pharmacology Pharmacy	1165	5.08
Tropical Medicine	812	3.54
Multidisciplinary Sciences	785	3.42
Plant Sciences	779	3.40
Infectious Diseases	741	3.22

What is the impact of Scientific Productivity in Nigeria?

Table 4 shows the total number of publications, citation count, country collaboration, and author collaboration and institution of the prolific authors who had published at least 50 articles in the study period.

Table 4: Scientific Productivity of most prolific Nigerian authors

Author	Institution	No. of Publi-cations	Total Citation	Country Collabo-ration	Author Collabo-ration
Gureje O.	University of Ibadan	166	7210	92	967
Ogunwande I. A.	Lagos State University	98	348	7	52
Farombi E. O.	University of Ibadan	94	1110	3	48
Ebenso E. E.	Obafemi Awolowo University	93	2182	8	44
Oboh G.	Federal University Technology Akure	91	871	4	34
Olusanya B. O.	Centre for Healthy Start Initiative, Lagos	82	3127	9	1254
Ikot A. N.	University of Port Harcourt	74	303	1	23
Ayo J. O.	Ahmadu Bello University	66	346	0	31
Luiselli L.	Rivers State University	66	175	8	36
Esimone C. O.	Nnamdi Azikiwe University	64	357	3	37
Ogunniyi A.	University of Ibadan	64	1019	18	174
Umoren S. A.	University of Uyo	63	2207	5	19
Obot I.B.	University of Uyo	61	2261	7	24
Onwujekwe O.	University of Nigeria	60	613	10	47
Sowunmi A.	University of Ibadan	59	583	5	39
Folayan M. O.	Obafemi Awolowo University	58	210	6	40
Shehu Y.	University of Nigeria	58	144	6	11
Singh J.	Ahmadu Bello University	59	384	0	9
Happi C. T.	Redeemers University	57	718	7	96
Eneji A. E.	University of Calabar	56	417	5	50
Menkir A.	Int. Inst .Trop. Agr. Ibadan	56	509	8	43
Attama A. A.	University of Nigeria	55	560	4	29
Gbotosho G. O.	University of Ibadan	55	577	3	36
Asiedu R.	Int. Inst. Trop. Agr.	53	201	11	35
Loto C. A.	Covenant University	53	163	1	17
Adebowale K. O.	University of Ibadan	50	1157	4	12
Bandyopadhyay R.	Int. Inst. Trop. Agr. Ibadan	50	822	14	29
Ezema F. I.	University of Nigeria	50	227	4	29

To test the relationship between citations, the number of publications and collaboration, correlation and regression analysis was conducted. Table 5 shows the coefficient for the Pearson correlation analysis. The results reveal that total citation is highly correlated with the number of publications, author collaboration, and country collaboration.

Table 5: Coefficients for Pearson correlation analysis

		Total Citation	No of Publica-tions	Author Collabo-ration	Country Collabo-ration
Total Citation	Pearson Correlation	1	.795**	.756**	.854**
	Sig. (2-tailed)		.000	.000	.000
No of Publications	Pearson Correlation	.795**	1	.594**	.776**
	Sig. (2-tailed)	.000		.001	.000
Author Collaboration	Pearson Correlation	.756**	.594**	1	.612**
	Sig. (2-tailed)	.000	.001		.001
Country Collaboration	Pearson Correlation	.854**	.776**	.612**	1
	Sig. (2-tailed)	.000	.000	.001	

****.Correlation is significant at the 0.01 level (2-tailed).**

the number of publications and histogram of residuals. Figure 3(a) reveals a significant linear trend, with moderate variability. This indicates that number of publications explains 63.3% of the variation in citations. It can be observed from figure 3(b) that out of 28 observation, only one residual falls outside the range [-2, 2], an analysis that does not reject the normality assumption.

Figure 4 shows the regression of total citation by

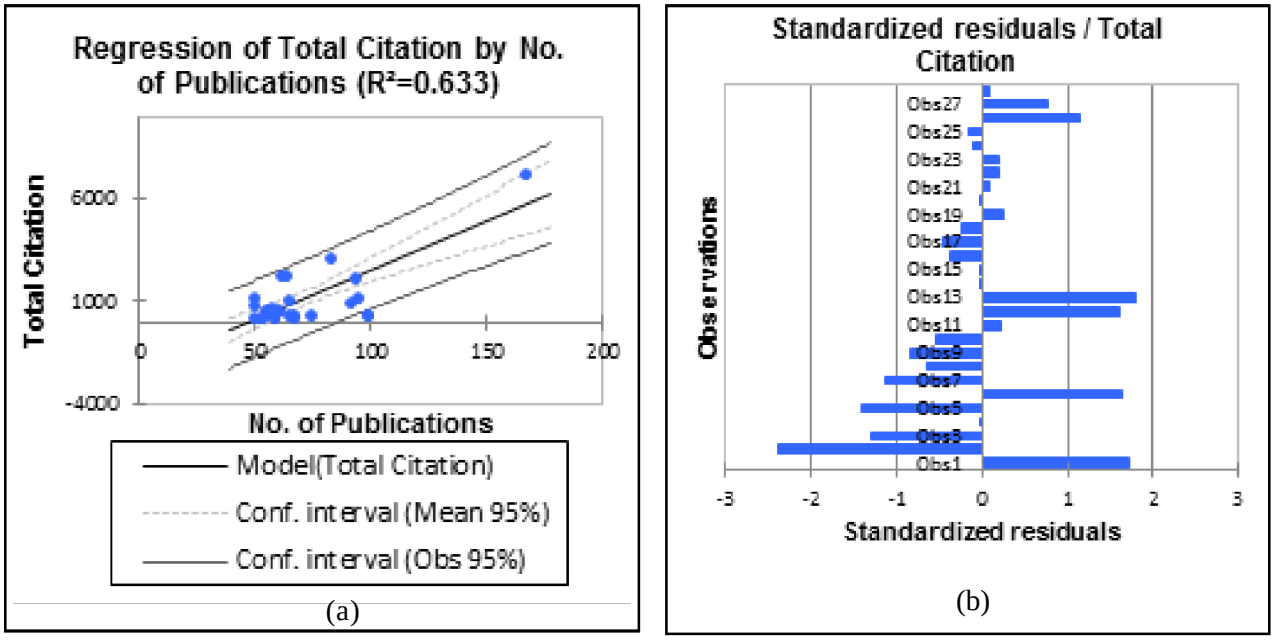


Figure 3 (a) Regression of total citation by number of publications and (b) histogram of residuals

author collaboration and histogram of residuals. Figure 4(a) reveals a significant linear trend, with moderate variability. This indicates that author collaboration explains 57.1% of the variation in citations. It can be observed from figure 4(b) that out of 28 observation, only 2 residuals fall outside the range [-2, 2], an analysis that allows for rejection of normality assumption.

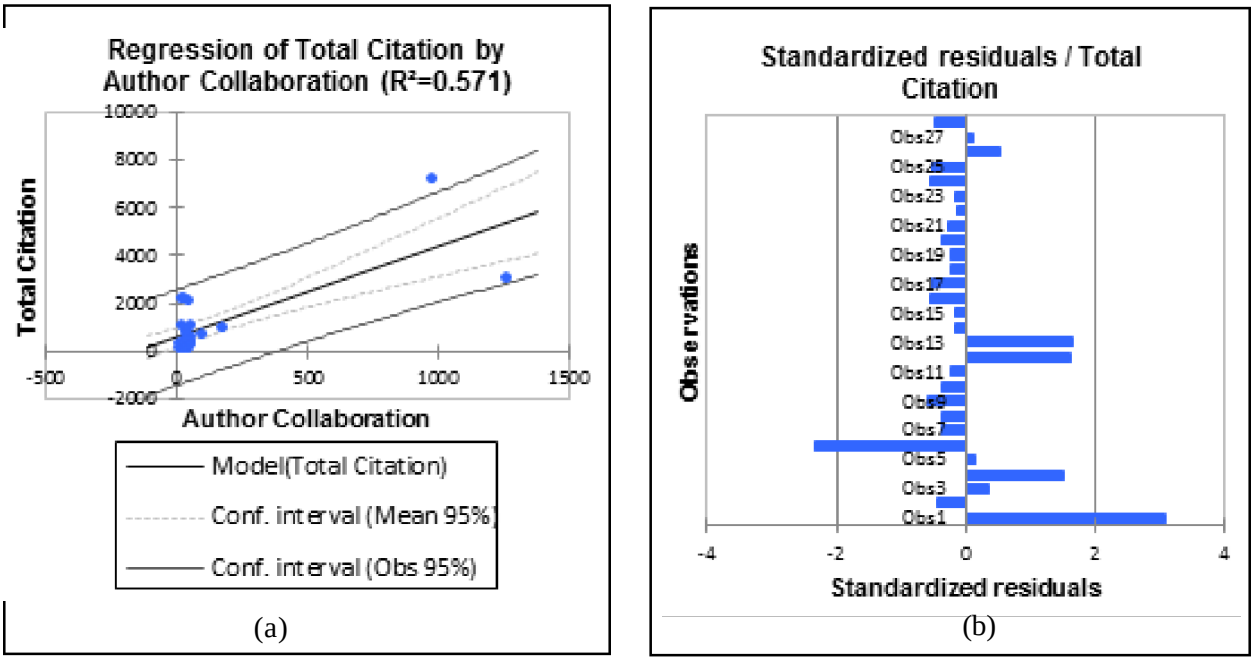


Figure 4 (a) Regression of citation by author collaboration and (b) histogram of residuals

Figure 5 shows the regression of total citation by country collaboration and histogram of residuals. Figure 5(a) reveals a significant linear trend, with high variability. This indicates that country collaboration explains 72.9% of the variation in citations. It can be observed from figure 5(b) that out of 28 observation, only 1 residual falls outside the range [-2, 2], an analysis that does not reject the normality assumption.

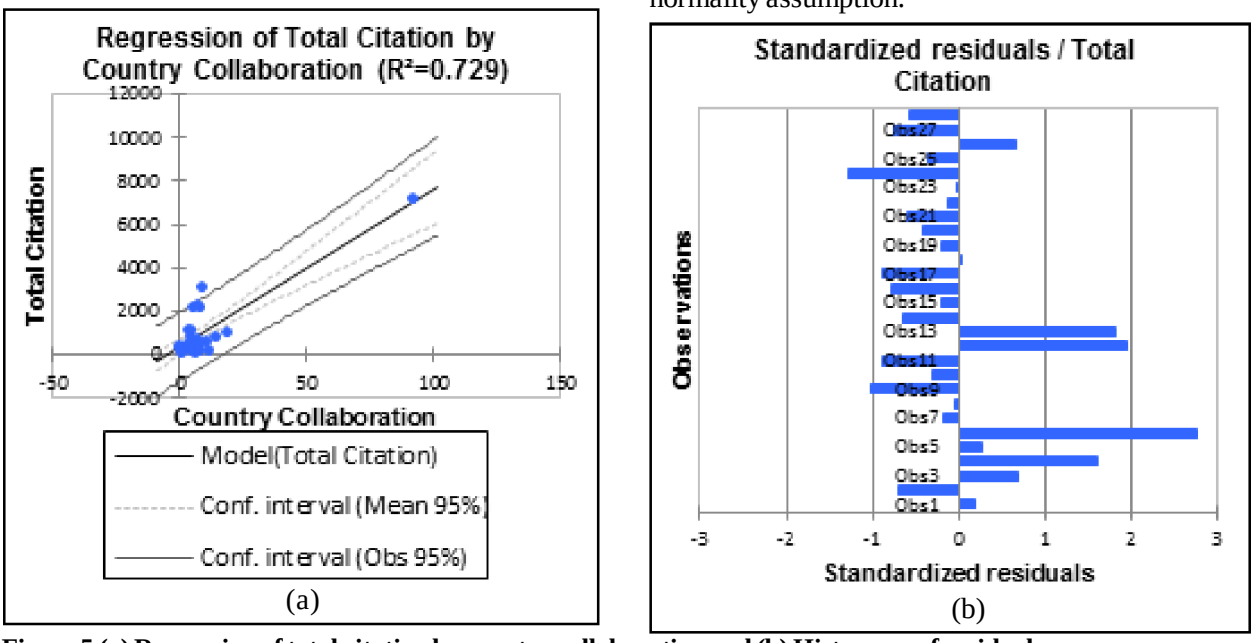


Figure 5 (a) Regression of total citation by country collaboration and (b) Histogram of residuals

Discussion

This study has examined the trends in publication output and the impact of scientific productivity in Nigeria.

Trends in Publication Output in Nigeria

The scientific output of researchers and research institutions provides government agencies, universities and other research institutions with useful information to make the decision about funding, tenure, and promotion. Scientific output in Nigeria, as noted in this study, is dominated by medical, health, technology, and science research fields. Findings reveal that Medicine General Internal is the most researched field in Nigeria, contributing 6.9 per cent of the total articles published in the study period. An analysis on the trend of publication output in Nigeria reveals that publication output has continued to increase moderately with a mixed growth pattern. Most institutions recorded an irregular rise and fall in their publication output. This fluctuation has led to no, weak and moderate monotonic trend in their publication output. Ani and Onyancha (2012) observed a similar pattern of growth in publication output in Nigeria between 2000 and 2010. They found a significant increase in publication output in the late 2000s, with a slight decrease in 2010. They attributed the pattern of increase in research activity to the improvement of government funding. Donwa (2006) explained that government accounts for 98.81% and foreign agencies account for 1.19% of research funding in Nigeria institutions. He noted that research funding in Nigeria is inadequate, not regular and therefore, not dependable. Yusuf (2012) attributed the mixed growth pattern in scientific output to inadequacy and irregularity of research funding. The inadequacy and irregularity of the research funding might have been attributed to the mixed growth pattern of publication output in Nigeria as noted in this study. To improve the growth pattern of publication output, government and funding agencies need to allocate enough funds for research activity as it is not possible to increase scientific output substantially without access to a regular and adequate research fund. Regular and adequate research funding can promote increased scientific output in Nigeria.

Impact of Scientific Productivity in Nigeria

Scientific productivity remains a prime source of scientific knowledge and innovation at national and global level. Impact of scientific productivity has been assessed for national science policies and development. To assess the impact of scientific productivity in Nigeria, the relationship between citation and collaboration, and the relationship between citation and number of publications were examined. An analysis of the relationship between citation and collaboration (author and country) reveals that citation and collaboration are strongly correlated, with moderate and strong linear relation. An increase in the number of collaborations leads to a proportional increase in the flow of citations. This is in line with many studies (Aldieri et al., 2017; O'Leary et al., 2015; Fu et al., 2012; Chuang and Ho, 2015) that an increase in collaborative activity is associated with high citation impact. Denise and Isabel (2016) reported that a greater number of co-authorship are associated with a greater volume of citations. Aldieri et al. (2017) noted that co-authored publications tend to receive more citations. Aksnes (2003) reported that a large number of scientists, often involved international collaboration, typically author highly cited papers. Bornmann (2017) noted, "Citation impact is typically greater when research groups collaborate, and the benefit strengthens when co-authorship is international". From this analysis, it can be noted that collaboration is a strong predictor of impact. Thus, Nigerian researchers must collaborate more to yield an "impactful" research and to advance scientific knowledge.

It is discernible from the analysis of this study that there is a strong correlation, with a moderate linear relationship between number of publications and citations. This implies that scientists who publish much also tend to publish works of high impact as measured by citations. A similar conclusion has been formulated by many studies. Haslam and Laham (2010) reported that the most influential researchers might be those who publish the most. Likewise, Larivière and Costas (2016) reported that the higher the number of papers a researcher publishes, the higher the proportion of these papers is amongst the most cited. Donaldson (2013) explained that total publications lead to higher citation rates. In line with this, Bosquest and Combes, 2013; Abramo et al 2014;

Van Raan, 2008; and Haslam and Laham, 2010 found a positive correlation between number of publications and citations, which supports the view that scientists who publish much also tend to publish works of high impact. Therefore, Nigerian researchers must endeavour to publish more in order to have a large impact on their field. This will in turn generate effective expertise in the various disciplines.

Conclusion

This study has evaluated the trends in publication output and the impact of scientific productivity in Nigeria from 2006 to 2016 using the Web of Science database. Findings of the study reveal that there are irregular rise and fall in the publication output which has led to no, weak and moderate monotonic trend in the publication output in Nigeria. The findings also reveal that citation is highly associated with number of publications and collaborations. Thus, this study recommends that government and funding agencies should allocate enough funds for research activity, as this will improve the growth pattern of publication output in Nigeria. This study further recommends that Nigerian researchers need to collaborate and publish more in order to yield an "impactful" research and to advance scientific knowledge.

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