Recent Trends in Academic Journal Growth

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Abstract

Since the publication of the first academic journal in 1665, the number of academic journal titles has grown steadily. In 2001, Mabe & Amin studied the pattern of growth in the number of academic journals worldwide, identifying three key development periods between 1900 and 1996. These three episodes are from 1900 to 1944, from 1944 to 1978, and from 1978 to 1996. The compound annual growth rates for each episode are 3.30%, 4.68% and 3.31% respectively. In this research, we seek to validate these findings, and extend on previous work to analyze journal growth patterns from 1986 to 2013. Our results show academic journals grew at an average rate of 4.7% from 1986 to 2013, which is very similar to the growth rate during the *Big Science* period observed in the previous study. Our results also show that academic journals had an estimated 92% *Active* rate, and 8% *Inactive* rate annually. Out of all *Active* journals, approximately 43% have high impact and reach *JCR* or *SJR* databases, and 26% have relatively higher impact and are thus collected in the *JCR* database. The comparison results of *Active* / *Inactive SJR* and *JCR* journals suggest that lower impact journals have a higher chance to become *Inactive* than higher impact journals. With the wide use of the Internet in academic science, our results expectedly show that the number of *Print-Only* journals is gradually decreasing while the number of *Online-Only* journals is increasing. The growth of *Online-Only* journals exceeds the growth of *Print-Only* journals in 2007, and the number of *Online-Only* journals exceeded the number of *Print & Only* journals in 2012. More than 30% *Newly Created* journals provide *Open Access*. It is suggested that we are experiencing the second journal boom in history and Internet technology has changed the academic publication system.

Keywords

Journal Growth, Journal Development, Academic Science, Academic Journal, Scholarly Journal,

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Introduction

"Without publication, science is dead" (Day & Gastel, 2012, p. 18), making clear the general assumption that all data and results should be published (Jacot, 1937). Commonly, academic work is published in a monograph, conference paper, academic journal article, or miscellaneous form (Björk & Hedlund, 2004), with journal and conference proceedings frequently indexed in bibliographic databases. There are a large number of bibliographic databases available, however Scopus and Web of Science (WoS), which were both established for the specific aim of facilitating citation searching and bibliometric analysis, are broadly considered most popular (Alonso, Cabrerizo, Herrera-Viedma, & Herrera, 2009; Meho & Yang, 2007). Of the academic works indexed in the Scopus bibliographic database and Web of Science bibliographic database, academic journals account for the majority scholarly work, compared to other publishing forms (Elsevier; Thomson Reuters).

Academic journals are published periodically in various research areas covering science, social science, and arts and humanities (Elsevier; Thomson Reuters). They function as forums for the introduction and presentation of scrutiny of new research, and the critique of existing research (Blake & Bly, 1993). Due to the importance and wide coverage of the work published in academic journals, they are the focus of numerous studies of the academic publishing system.

Literature examining the academic publishing system focuses on a number of key areas. Firstly, many scholars have undertaken studies that effectively consider their involvement in the system itself in terms of authorship, co-authorship (Cronin, Shaw, & La Barre, 2003), manuscript editing (Mišak, Marušić, & Marušić, 2005), and financial interests (Krimsky, Rothenberg, Stott, & Kyle, 1996, 1998). The second key area, the peer review process, lies at the core of academic publishing system. The peer review process has been studied (Felton et al., 2009; Hames, 2008; Relman, 1990) and guidelines established to drive best practice (Hames, 2008). Thirdly, as the subsequent step after the peer review process, the actual publishing process itself has been studied. In this context, publishing relates to economics including cost and pricing (Byrd, 1990; Morris, 2005; Oppenheim, Greenhalgh, & Rowland, 2000), distribution formats such as electronic publishing (Boyce & Dalterio, 2008; Peek & Pomerantz, 1998), and studies on publishing in different countries (Hew, 2001; Rowland, 2005; Tenopir & King, 1997).

Most of the work in the academic journal space is based on performance measures and includes bibliometric studies involving citation analysis from bibliographic databases, such as Web of Science (Kalaitzidakis, Mamuneas, & Stengos, 2003), Scopus (Moed, 2010), and so forth. The measurement of performance can occur at differing scales; from the individual paper and individual academic (Hirsch, 2005), to journals (Kalaitzidakis et al., 2003; Moed, 2010), research institutes (Hazelkorn, 2009), and even countries (Hazelkorn, 2009). At the journal level, journal development trends and patterns have been widely studied. This includes studies that focused on historical development (Zitt & Bassecoulard, 1998), economics (Rosenstreich & Wooliscroft, 2006), internationalization (Buela-Casal, Perakakis, Taylor, & Checa, 2006), and current and future trends (Buela-Casal et al., 2006; Ren & Rousseau, 2002).

From this broad research space, the analysis of current and historical journal development, or growth, forms the basis for this research work. In the following background section, we discuss historical journal growth, and recent changes in journal growth patterns. In Section 2 we provide some background on the growth and development of the academic publishing area. Section 3, "Methodology", follows where we describe the data sources, data collection, and the research methodology. This is followed by the presentation of results and the discussion of findings in Section 4, and finally conclusion, limitations and possible future work in Section 5.

Background

History of journal growth

Since the emergence of the first modern journal, *Le Journal des Scavans*, published in France in 1665 (Jinha, 2010, p. 1), the number of academic journal titles has grown steadily (Mabe, 2003). In the last 45 years, many studies into the growth in the number of academic journal titles have been conducted (Björk, Roos, & Lauri, 2008; De Solla Price, 1963; Jinha, 2010; Morris, 2007; Tenopir & King, 2009). In 1963, Derek de Solla Price predicted that there would be 1 million journal titles by 2000 after he plotted the growth of journal titles from 1665 to 2000 (De Solla Price, 1963). However, recent studies show the number of journal titles is far less than the initial estimation. *Ulrich's Periodical Directory*, published since 1932, is described as the most comprehensive source for monitoring the number of, and growth in, periodical titles (Tenopir and King, 2009). This directory is fully described in the following "Data Sources and Methodology" section. By restricting searches to Ulrich's data, there were only approximately 23,750 active scholarly journal titles in 2006 (Björk et al., 2008), and 26,406 in 2009 (Jinha, 2010). These figures are far less than those suggested by De Solla Price's predictions, however they do demonstrate an increasing trend that has been investigated by other scholars.

Based on data from *Ulrich's Periodical Directory*, a study by Mabe and Amin (2001) on the growth of journal titles identified three distinct growth periods over the period from 1900 to 1996. The first of these periods extended from 1900 to 1945, during which time the growth rate was 3.30%. The second period, from 1945 to 1980, saw the growth of academic peer-reviewed journals increase to 4.68%. Mabe and Amin label this the *Big Science* period, and contribute the growth during this stage to the ending of World War II. From 1980 to 1996, the third period of

development, saw the growth of journal titles return to the previous rate of 3.31%. The growth pattern is represented in the Figure 1.

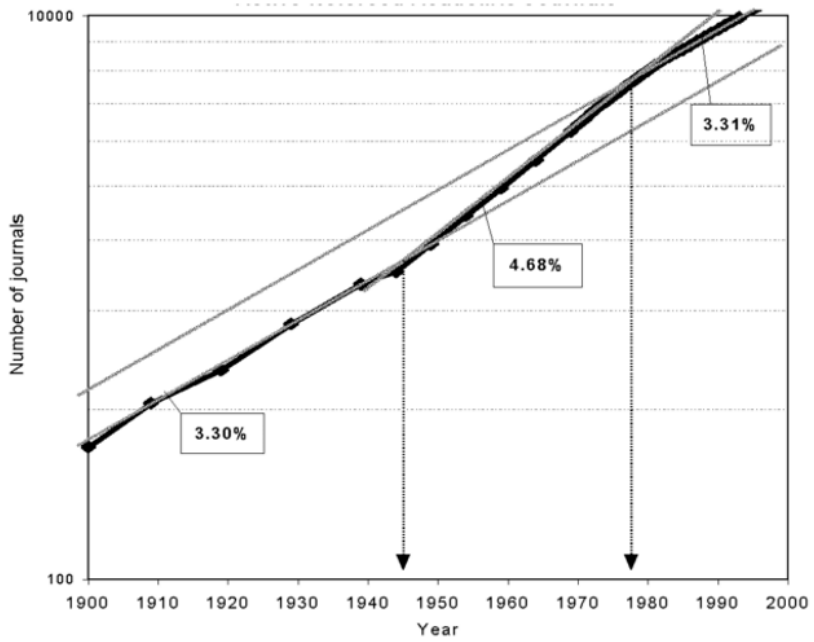

Fig. 1 Growth characteristics of active referred academic journals over the 20th century (Mabe & Amin, 2001)

Following on from his earlier work in 2001, Mabe (2003) not only summarized that the journal growth rates have been consistent over time, with an average rate of 3.46% over the period of the last three centuries, but also concluded that there is a correlation between the number of journal titles and the number of scholars, suggesting a possible relationship between the number of journal titles and R & D funding. Mabe also suggested that the basic dynamic of journals reflecting groups of scientists and the development of science is unlikely to be affected by new technology, while new technologies will certainly affect usage behavior.

A number of similar studies were conducted based on the data from *Ulrich's Periodical Directory*. Morris (2007) examined the landscape of journal publishing including the number of publishers, number of journals, split between commercial and nonprofit, by business model, and by geographical location. Tenopir and King (2009) studied the overview of the growth in journal publishing including the growth of the journal titles and online journals, the changing number of articles per journal, and even the changing length of each article. Replicating Björk et al. (2008), Jinha (2010) calculated the number of active refereed academic journals in 2009. Based on the proportion of Information Sciences Institute (ISI) and non-ISI titles in all journals, Jinha (2010) estimated that there had been 50 million scholarly articles in total published at the end of 2008.

Increasing interest in the growth of the academic publication system, as evidenced by the increasing number of articles examining the phenomena, is fueled by a number of drivers. Since the 1990s, the academic publication system has undergone considerable changes (Tenopir & King, 2009). For example, introduction of the Internet, technical advances with online journals (Björk & Hedlund, 2004), financial considerations for journal operations with the option of open access (Guerrero & Piqueras, 2010), and differential pricing of print and online subscriptions (Statzner & Resh, 2010) are changing the underlying publishing model of operators within the system. External drivers such as the use of quantity and quality measures of publications as institutional performance metrics in global university rankings (Hazelkorn, 2013) have manipulated both individual and institutional agendas since 2003. Linked to this is the decision making associated with institutional budgets or individual careers , and increased choice and competition for relevant articles due to journal proliferation and increased specialization have impacted on the system (Statzner & Resh, 2010). The revolution in the academic publication system is not only limited to these evolving factors. In summary, complex changes such as new technology, globalization, and the increasing dominance of commercial interest are affecting the academic publication system.

The evolving nature of the publication system creates the need for continued monitoring and analysis. As higher education institutions seek to compete in the increasingly global higher education market, insights into how the system is growing and changing are useful strategic decision-making inputs. In this research, we address the question of "What changes have occurred in the academic publication system in the last 30 years?" Specifically, this paper presents an analysis of journal development characteristics in terms of the growth of journal titles at a macro level in recent years.

The primary purpose of our research is to investigate the current growth and development of peer reviewed academic journal titles. In order to obtain this overview of the development of the system, we seek the answers to the following specific questions:

- RQ1: What is the growth rate of journal titles in the last 30 years?
- RQ2: What is the survival rate of journal titles in the last 30 years?
- RQ3: What is the distribution of journal impact measured across bibliographic databases?
- RQ4: Have factors, such as technology and the Internet, changed the distribution format of journals?

Many potential sources of data in relation to academic journals are available to assist in answering these questions. In this research, we use *Ulrich's Periodicals Directory (Ulrichs)*, Journal Citation Report (*JCR*) from Web of Science (*WoS*), and SCImago Journal & Country Rank (*SJR*) from Scopus. Each database provides us with voluminous detailed information on academic journals, and their use in this research is described in the following methodology section.

Methodology

Data Source - Ulrich's periodicals directory (Ulrichs)

Ulrich's Periodicals Directory (*Ulrichs*) is regarded as the most complete and consistent source for monitoring the number of periodical titles (Jinha, 2010; Tenopir & King, 2009). *Ulrichs* contains all periodicals including *Active* or others, *Journal* or others, and *Academic / Scholarly* or *others*. In *Ulrichs*, the definition of *Active* means that the periodical title is currently active in publishing, rather than *Announced Never Published*, *Ceased*, *Forthcoming*, *Merged / Incorporated*, *Researched / Unresolved*, or *Suspended*. The definition of Journal means that the periodical title is published in the format of journal, rather than *Abstract/Index*, *Database*, *Magazine*, *Bulletin*, *Catalog*, *Directory*, *Monographic Series*, *Newsletter*, *Proceedings*, *Yearbook*, *Report*, or *Handbook / Manual*. The definition of Academic / Scholarly means that the periodical title is publishing with academic content, rather than *Bibliography*, *Consumer*, *Trade*, *Corporate*, or *Government*. For Journal periodicals, there are two types of journals: *Refereed* / *Peer Reviewed*, or Not *Refereed* / *Peer Reviewed*. *Refereed* Journal means that the journal requires peer review process. In this paper, our research focuses only on the refereed academic journals.

Several studies on the number or growth of academic journal titles have been conducted through this directory (Björk et al., 2008; Jinha, 2010; Mabe, 2003; Mabe & Amin, 2001; Morris, 2007; Tenopir & King, 2009). From these, a summary of historical numbers of active refereed academic journal titles are listed in Table 1.

Year	Count	Source
2006	23,750	Björk et al. (2008)
2007.10	23,658	Tenopir and King (2009)
2008.02	23,973	Tenopir and King (2009)
2009	26,406	Jinha (2010)
2010.04	28,838	Tenopir and King (2009)
2011.11	57,736	Tenopir and King (2009)

Table 1: Published data of active refereed academic journal counts in *Ulrichs.*

Although these data provided an accurate measure of journal titles at the time of the previous publications, the data collections were not evenly spread out through the years, and the data cleaning processes could be different in each study. Therefore, consistency and completeness of these data can not be ascertained and compared, and they will thus not be used for this research. However, *Ulrichs Periodical Directory*, the same data source, will be adopted to investigate the total number of refereed academic journal titles to facilitate comparison of the results in this research to those from previous studies. Additionally, it is easily recognizable that the journal data dated in September 2011, documented by Tenopir & King (2009), does not follow the growth pattern discovered by Mabe (2003). There is quite a major jump from 2010 to 2011 in the total active refereed academic journal titles. The possible reasons for this anomaly will be considered in the discussion section.

In these studies, online and CD Rom versions of *Ulrichs* have been used as data sources. The online version of *Ulrichs* has enabled identification of academic and scholarly refereed journals (Morris, 2007). CD Rom versions of Ulrichs have a few different settings when compared to the online version. In 2003, Mabe conducted on his search using *Ulrich*s CD Rom, in which there is no search parameter called *Journal*. Therefore, in his search strategy, Boolean AND NOT was used to eliminate titles containing one of several types of indicators, including audio-cassette, bibliography, Braille, broadsheet, and 20 other similar designations. These differing data formats also impact on the ability to compare the data over time.

Data Sources - Bibliographic

Web of Science, Scopus, and Google Scholar are recognized as the three main scholarly bibliographic data sources (Alonso et al., 2009; Meho & Yang, 2007). Each has developed its own metrics to measure the value or quality of academic papers or academic journals. The journal lists from Web of Science, Scopus, or Google Scholar not only show the ranking of the academic journals, but also reveal the total number of the journal titles. The complete Google Scholar is not obtainable on the Internet. Therefore, for this research, we adopt Journal Citation Report (JCR) from Web of Science, and SCImago Journal & Country Rank (*SJR*) from *Scopus*.

JCR is not free. It can be downloaded through subscription via http://thomsonreuters.com/journal-citation-reports/ or from a subscribed university library. For each calendar year, *JCR* has two editions: *Science* and *Social Sciences*. We downloaded both for each year and simply summed up the total journal titles as one year count.

SJR is free to download and available via http://www.scimagojr.com/journalrank.php. On the interface, the parameters for the search are *Subject Area*, *Subject Category*, *Region / Country*, and *Year*. Except for the *Year* parameter, which needs to be specific, the other parameters do not need to be specified. In May 2015, we downloaded *SJR* reports based on calendar years from 1999 to 2013, and counted the sum journal titles of each calendar year.

Data Collection

On 27 February 2015, we downloaded all the data from *Ulrichs*, which is available on the Web via *http://ulrichsweb.serialssolutions.com/*. A total of 122,509 records were found, including 18,099 duplicates. After removing the duplicates, there were 104,410 unique *Ulrichs* records in total. We then followed the same search design as previous studies (Björk, 2007; Morris, 2007; Tenopir & King, 2009) and conducted a search with the following parameters: *Academic/Scholarly*, *Refereed*, and *Journal*, and further a search with the parameter *Active*.

This search yielded a total of 59,876 academic refereed journal titles out of 104,410 unique titles in the entire directory. Based on the journal titles returned, we conducted data cleansing based on the unique journal title and publisher to remove duplicate entries. This yielded a total of 36,442 unique academic referred journal titles. The workflow of the data collection and cleansing process is shown in Figure 2.

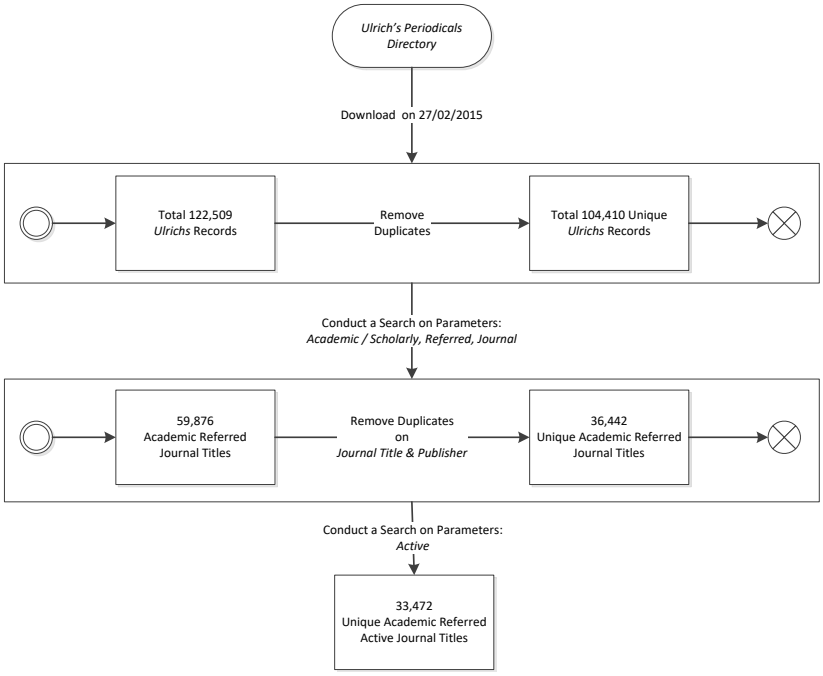

Fig. 2 Workflow of data collection and cleansing on active refereed academic journal dated on 27/02/2015

In order to answer the research questions for this study, a number of specific measures were calculated from the downloaded data sources. In particular, research question 1 and 2 required some consideration and categorization of variables with the data. The calculation of these measures, and the consideration of data variables, as they relate to the research questions are provided below.

RQ1: What is the growth rate of journal titles in the last 30 years?

In *Ulrich's Periodical Directory*, seven classification types are used to describe a journal's status. They are: *Researched / Unresolved*, *Announced Never Published*, *Forthcoming*, *Merged / Incorporated*, *Suspended*, *Ceased*, *and Active*. We categorize these seven types into *Active*, *Inactive*, and *Unpublished*. From these seven types, we categorize *Researched / Unresolved*, *Announced Never Published*, and *Forthcoming* journals into *Unpublished*. Since they have no publications, they are not considered in this research. From the remaining classes, *Merged / Incorporated*, *Suspended*, and *Ceased* are considered as *Inactive*. Although journals in the *Merged / Incorporated* class can be considered to still be in operation, the process of consolidation into a new form effectively discontinues the original incarnation of the journal and they are thus considered *Inactive*. Only *Active* journals are considered as *Active*. Some journals have progressed through several operational statuses. For example, the Journal of Orthopaedic Surgery ceased Microform format distribution and retained print and online *Active*. In this scenario, the Journal of Orthopaedic Surgery is regarded as *Print & Online Active* journal. In another example, Game and Wildlife Science turned print version to *Merged / Incorporated* and keep online version *Active*. In this scenario, Game and Wildlife Science is regarded as *Online-Only Active* journal as this is its most current operational status. In this research, the historical statuses are not taken into consideration and only the final and most recent status is used for analysis. In reality, journals may change title however the ISSN stays the same. This research does not consider the title changes, rather considering the journal as an entity via ISSN.

Although the analysis of Mabe (2001) only included the data until 1996, we capture 10 years data prior to 1996 to demonstrate the pattern before this point. Considering the possible latency in data collection for *Ulrichs*, 2014 is not considered for this research. As a result, we collected the data from 1986 to 2013.

Firstly, we count all the *Newly Created* journals based on the specific year. Secondly, based on these *Newly Created* journals, we count all *Active* journals and *Inactive* journals depending on the journal status as in February 2015. In another expression, the number of *Newly Created* journals in a particular year is equivalent to the total number of *Active* journals and the total number of *Inactive* journals, plus the number of *Unpublished* journals. Thirdly, expected *Newly Created* number and Expected *Active* journal counts were calculated based on the data from 1986 to 2013. Expected values provide a smoother and polished growth curve. In our research, the expected values are

calculated based on the growth equation in Microsoft (MS) Excel Spreadsheet. The calculation equation in MS Excel (Microsoft) is:

Y = GROWTH(known_y's, [known_x's], [new_x's], [const]).

To calculate Expected Number of *Newly Created* Journals in Year X, MS Excel arguments are set in Table 2.

known_y's	A set of known y-values: Number of *Newly Created* Journals from Year 1986 to Year 2013.
[known_x's]	A set of Years from Year 1986 to Year 2013.
[new_x's]	Year X in the group of Year 1986 to Year 2013.
[const]	It is set to TRUE.

Table 2: arguments settings to calculate Expected Number of Newly Created Journals in Year X in MS Excel

To calculate Expected Number of *Active* Journals in Year X, Excel arguments are set in Table 3.

known_y's	A set of known y-values: Number of *Active* Journals from Year 1986 to Year 2013.
[known_x's]	A set of Years from Year 1986 to Year 2013.
[new_x's]	Year X in the group of Year 1986 to Year 2013.
[const]	It is set to TRUE.

Table 3: arguments settings to calculate Expected Number of Active Journals in Year X in MS Excel

The MS Excel GROWTH function implements a smoothed exponential growth curve that can be achieved via a standard mathematical formula. The equation to calculate the growth rate of different types of journals is:

$$y = b * m_1^{x_1} * m_2^{x_2} * ... m_n^{x_n}$$

where, the x's are the independent variable ranges; y is the dependent variable; and the m's are constant bases for the x values; and b is a constant.

Finally the growth rates of expected *Newly Created* and *Active* journals were calculated. The expected growth rate is the value in the current year compares with the value in the previous year. The calculation equation for Expected *Newly Created* Growth Rate in Year X is:

$y = \frac{x - x_1}{x_1}$ where *x* stands for Expected Number of *Newly Created* in Year X, x_1 stands for Expected Number of *Newly Created* in Year X-1;

The calculation equation for Expected *Active* Growth Rate in Year X is:

$y = \frac{x - x_1}{x_1}$, where *x* stands for Expected Number of *Active* in Year X, x_1 stands for Expected Number of *Active* in Year X-1.

For the above four equations, Year X represents the year the journal was created.

RQ2: What is the survival rate of journal titles in the last 30 years?

In order to better understand the survival rate of journals, the percentages of *Active* and *Inactive* journal titles are analyzed over time. *Active* rate is the percentage of *Newly Created* journals in the specific year that are still *Active* as at February 2015, thus each year over the period from 1986 to 2012 has an *Active* rate. *Inactive* rate is the percentage of *Newly Created* journals in the specific year that are already *Inactive* as at February 2015, thus each year also has an *Inactive* rate. The percentage rates are calculated based on the data from Table 4. The calculation equation for *Active* rate of Year X is:

$y = \frac{x_a}{x_c}$ where x_a represents total *Active* journal count and x_c represents *Newly Created* journal count in Year X;

The calculation equation for *Inactive* rate of Year X is:

$y = \frac{x_i}{x_c}$ where x_i represents total *Inactive* journal count and x_c represents *Newly Created* journal count in Year X.

Results and discussion

The results of the analysis of academic publication data are provided in the following sections. To answer the first research question, the growth rate results from our current analysis of *Ulrich's Periodical Directory* are compared to journal counts from previous research. This is followed by the second research question – survival rate of journals. The survival rate is determined by the status of journals, such as *Active* and *Inactive* (which includes *Merged*, *Suspended*, and *Ceased)*. Next, to explore the third research question, the impact of journals is measured from two world major bibliographic databases: Scopus and Web of Science. Lastly, to tackle the fourth research question, the distribution formats of journals over time are analyzed.

RQ1: What is the growth rate of journal titles in the last 30 years?

Using the process described in the methodology section, the actual number, and resulting expected number, of newly created and active journals for the period from 1986 to 2013 are shown in Table 4.

Year	Newly Created	Active as in 2015.02	Inactive as in 2015.02	Expected Newly Created	Expected Active
1986	447	394	50	434.07	372.34
1987	465	400	55	452.43	389.85
1988	489	421	61	471.58	408.19
1989	467	414	45	491.53	427.38
1990	491	435	48	512.33	447.48
1991	552	495	50	534.00	468.52
1992	537	475	56	556.60	490.55
1993	567	515	45	580.14	513.62
1994	592	524	65	604.69	537.78
1995	658	560	95	630.27	563.06
1996	699	621	76	656.94	589.54
1997	745	651	86	684.73	617.26
1998	736	659	64	713.70	646.28
1999	745	670	68	743.90	676.68
2000	811	743	64	775.37	708.50
2001	751	682	66	808.18	741.81
2002	775	704	65	842.37	776.70

2003	756	677	71	878.01	813.22
2004	891	802	81	915.16	851.46
2005	858	818	36	953.88	891.50
2006	960	903	47	994.24	933.42
2007	1089	1037	47	1036.30	977.31
2008	1142	1100	43	1080.15	1023.27
2009	1072	1039	32	1125.85	1071.39
2010	1253	1228	23	1173.48	1121.77
2011	1499	1426	73	1223.13	1174.52
2012	1378	1321	57	1274.88	1229.75
2013	1146	1140	6	1328.82	1287.58

Table 4: Number of *Newly Created* Journals, *Active and Inactive* Journals as in 2015.02, Expected *Newly Created* and *Active* Journals, Growth Rates of Expected *Newly Created* and *Active* Journals by Year

Based on MS Excel Spreadsheet Growth equation, the growth rate for Expected *Newly Created* journals is 4.23% and the growth rate for Expected *Active* journals is 4.7%. To better understand the growth pattern for the three types of journal counts, the journal data is shown on a scatter plot in Figure 3.

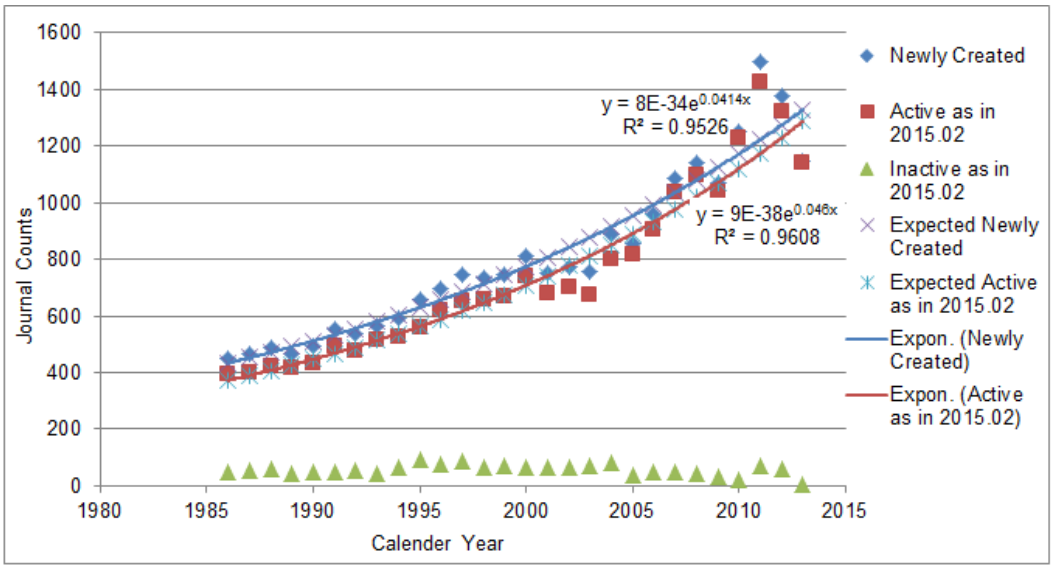

Fig. 3 Count of *Newly Created, Active* and *Inactive* journal titles in specific years, as in February 2015 from *Ulrichs*

A trendline is introduced to this chart to better show the overall growth trend. An exponential trendline was fitted to the Newly Created and Active data with R-square values of 0.95 and 0.96 respectively, indicating a good fit. Visually, the exponential trendlines for the Expected *Newly Created* and *Active* journals share a very similar growth pattern. In terms of *Inactive* journals, there is no apparent trend or change over time. The exponential trendline over active journals reinforces the calculated result of expected active growth rate of 4.7%.

RQ2: What is the survival rate of journal titles in the last 30 years?

The percentages of *Active* and *Inactive* journals between 1986 and 2012 are shown in Figure 4. Across the 29 years from 1986 to 2012, the average *Active* rate is approximately 92%, leaving an average *Inactive* rate of approximately 8%, annually.

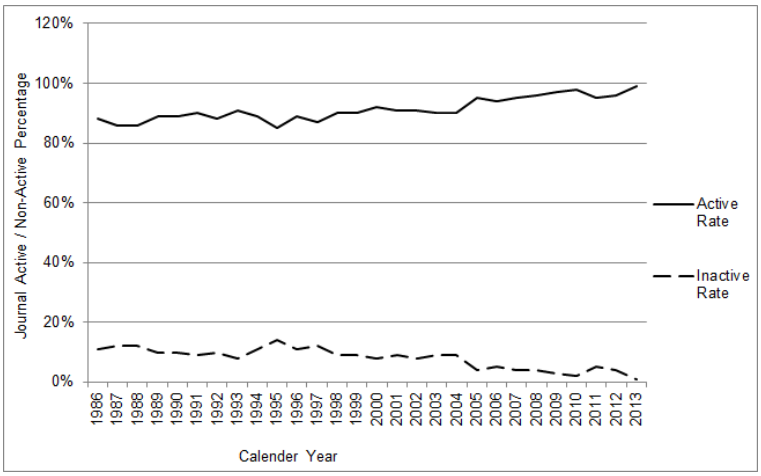

Fig. 4 *Active* and *Inactive* rate for 1986-2012, as per February 2015 data from *Ulrichs*

From Figure 4 it can be observed that the ratio between the *Active* to *Inactive* journals remains stable between 1986 to 2004. From 2004, the proportion of *Active* journals increases while the corresponding proportion of *Inactive* journals decreases. There are two possible explanations for this change; 1) the bibliographic data was collected in February 2015, thus if a journal is newly established at a year close to 2015, it has a larger possibility of remaining active in 2015 than a journal founded at much earlier year than 2015, or 2) as the time progresses, the journals have an increased chance of discontinuing publishing, or becoming *Inactive*. To further study the timeframe for an *Active* journal to become *Inactive*, or the lifecycle of journals, we produced a survival timeframe graph for journals in Figure 5. To create this graph, we first identified all *Inactive* journals from Ulrichs with a valid *Start Year* and a valid *End Year*. Secondly, we calculated the survival years for these journals by simply calculating *End Year – Start Year*, alternatively we could call it death age. Thirdly, we grouped and summed the journals with the same death age to create the frequency distribution. Lastly, the numbers of *Inactive* journals based on the death age were plotted on a line chart.

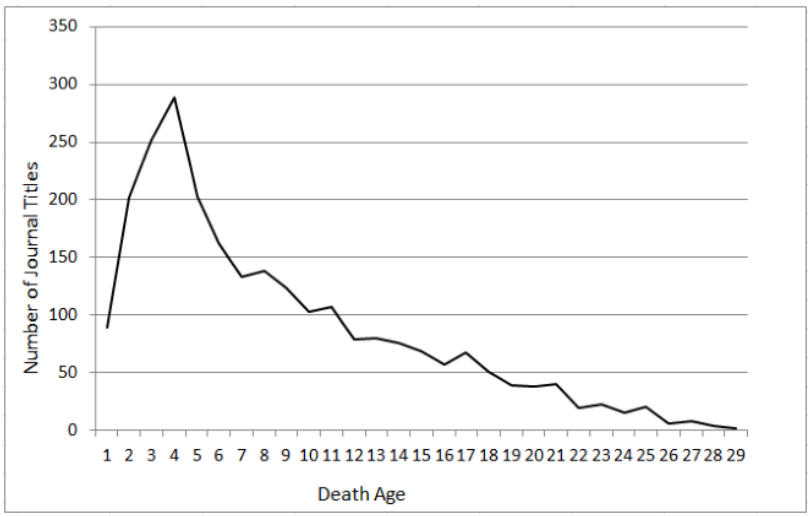

Fig. 5 Death age for *Inactive* journals in *Ulrichs*

From this analysis, an obvious peak occurs indicating that 4 years after commencement is a critical milestone for journals. A large number of newly created journals appear to survive to the one-year mark, however the number of journals becoming inactive increases substantially in the 1-4 year period after commencement, reaching a peak in year 4. After this, there are less and less journals becoming *Inactive*, with a somewhat noticeable plateau occurring 10 years after commencement.

Inactive journal types

Inactive journal titles include three specific types: *Ceased*, *Merged / Incorporated*, and *Suspended*. The percentage rates of *Ceased* Journals, *Merged / Incorporated* Journals, and *Suspended* Journals as a proportion of all *Inactive* journal titles were calculated, with this presented in Figure 6. The X-axis represents the calendar years while the Y-axis shows the percentage of journals of each status in respect to all *Inactive* journals. On average, *Ceased* journals account for 88% of *Inactive* journal titles, *Merged / Incorporated* journals account for 10% of *Inactive* journal titles, and *Suspended* journals account for 2%, across all years from 1986 to 2013. Thus the majority of journal titles are classified as *Inactive*, and are no longer part of the journal industry. Only 10% of journals are merged with other journals, and thus remain in the industry. It is obvious that the *Inactive* rate has increased with time. It is also recognizable that the *Inactive* rate for *Ceased* journals and *Merged* Journals becomes relatively stable after 10 years.

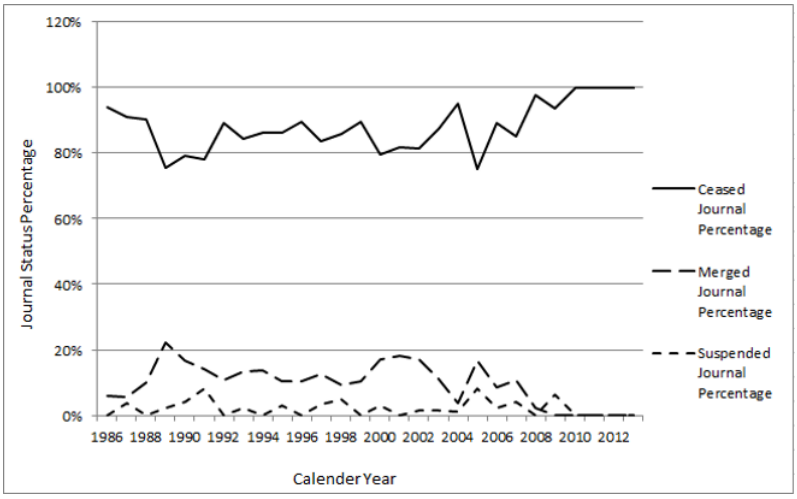

Fig. 6 Percentage of *Ceased*, *Merged*, and *Suspended* journal titles among all *Inactive* journal titles in specific years, as in February 2015 from *Ulrichs*

RQ3: What is distribution of journal impact measured across bibliographic databases?

Journal Citation Report (*JCR*) from Web of Science & SCImago Journal & Country Rank (*SJR*) from Scopus

The *JCR* data is downloadable from 1997 to the current date, while *SJR* is downloadable from 1999. The number of journal counts for both *JCR* and *SJR* are displayed in Figure 7. It can be observed that *SJR* has a higher volume and a higher growth rate than *JCR*. Each year, *JCR* grew at an average rate 3% and *SJR* at 4.5% from 1997 to 2013. Although the total number of journals for each year are available, journal impact values are only provided as current at the time of download. Thus it is not possible to consider the change in journal impact over time.

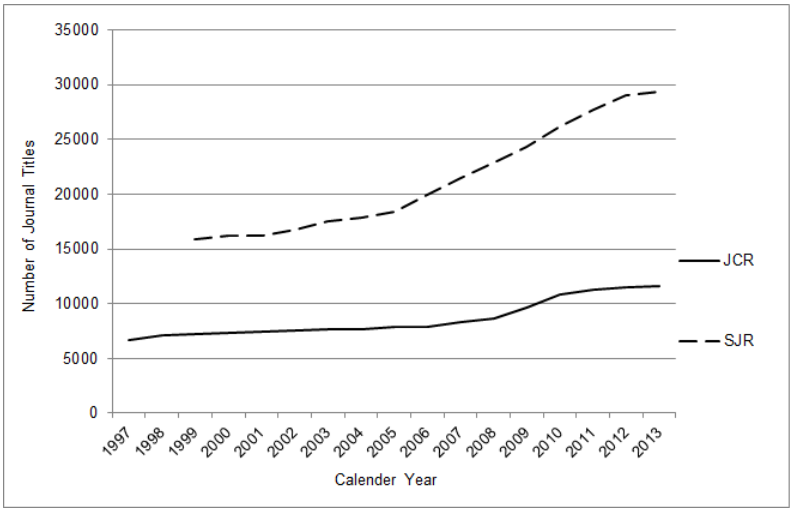

Fig. 7 The number of *JCR* and *SJR* journals from 1997 to 2013

After growth rate, we studied the growth pattern. Then we mapped the growth rates on a line chart shown in Figure 8.

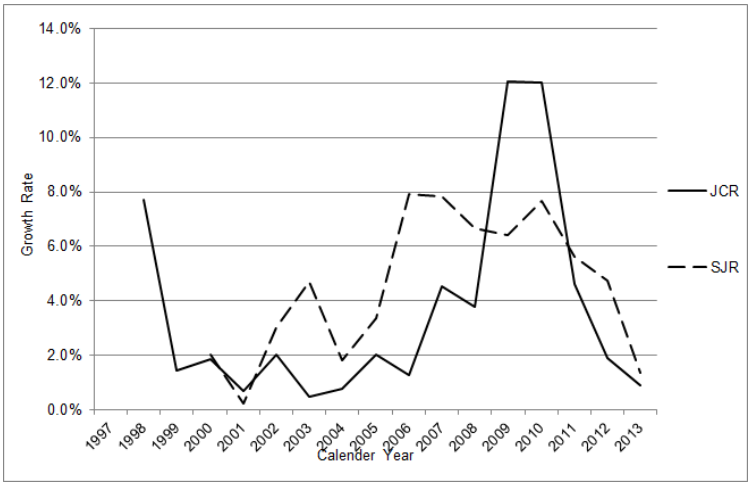

Fig. 8 *JCR* and *SJR* growth rates from 1997 to 2013

Although *JCR* and *SJR* grew at different rates from 1997 to 2013, both academic bibliographic databases exhibit a simliar growth pattern. There is growth from early 2000, and both sources reach a peak in 2010, then return to the earlier growth rate at the end of 1990s and early 2000s.

We downloaded the *JCR* list published in 2013 and *SJR* list published in 2013. *JCR* contained 11519 journals, and *SJR* contained 29385 journals. Of these, 10534 journals in both lists have the same ISSN or journal title. Each *SJR* journal has a *SJR value*, which expresses the average number of weighted citations Scopus received in the selected year by the documents published in the selected journal in the three previous years (Elsevier). For example, weighted citations received in year X to documents published in the journal in years X-1, X-2 and X-3. The *SJR value* can be regarded as the academic impact of a journal. *SJR values* in *SJR* list range from 0.1 to 45.894, while the average *SJR value* for all 29385 *SJR* journals is 0.56. 10534 journals are found in both *SJR* list and *JCR* list. The average *SJR value* for these 10534 journals is 1.18, which is more than double compared to the average *SJR value* of 0.56 for all *SJR* journals. 18851 journals are found only in *SJR* list, but not in *JCR* list. However, the average *SJR value* for *SJR* journals which are not listed in *JCR* is only 0.26, which is less than half of the average *SJR value* of 0.56. From this comparison, it can be concluded that journals found in both the *SJR* list and *JCR* list have a higher impact than journals found in only the *SJR* list but not the *JCR* list. This result could suggest that journals from the *JCR* list have a higher impact than journals from the *SJR* list. The quantitative relationship is shown in Figure 9.

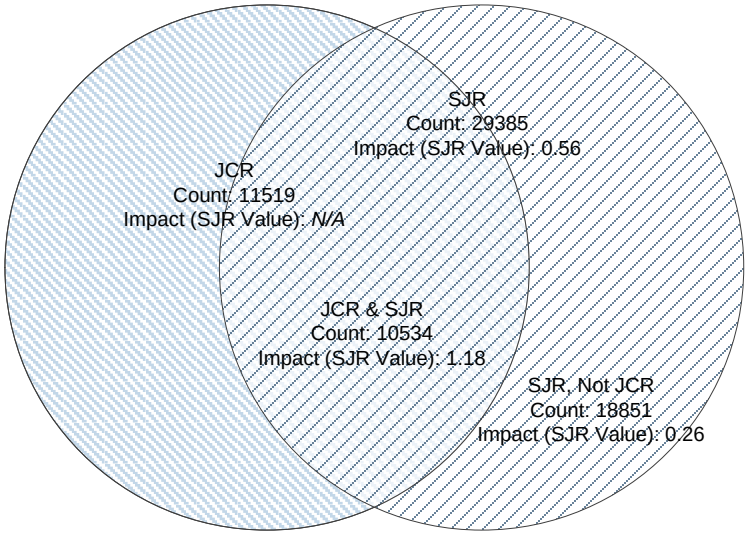

Fig. 9 The relationship between *JCR* and *SJR* in 2013

There are differences between the SJR and JCR impact measures that should be considered when interpreting results. There are 30370 unique journals in total from both the *SJR* list and *JCR* list, including 11519 *JCR* journals and 29385 *SJR* journals. *SJR value* covers 29385 out of 30370 journals, leaving 985 journals without any impact measure. The *JCR* list contains impact values for all the *JCR* journals. However, the *JCR impact value* covers only 11519 journals, which leaves 18851 journals without any impact measure. Therefore the advantage of using the *SJR* value to measure the impact of journals is one simple value to measure the impact for maximum number of journals. The *SJR* value represents the impact counted from all journals in *SJR* list. Although the *SJR* list covers more than 96% of journals in the *JCR* and *SJR* lists, there are 985 journals from the *JCR* list cannot be taken into considerations. That means the citation counts from these journals are lost. The disadvantage of using the *SJR* value to measure journal impacts is the bias in the impact calculation of *JCR* journals. There is a limit for the *SJR* list. The limitation of using the *SJR value* to measure journal impact is the limitation of the *SJR* list. After all, the *SJR* list does not cover all journals. Besides the 985 journals from the *JCR* list, any journals beyond the *SJR* list cannot be measured by the *SJR* values.

Quantitative relationship among *Ulrichs*, *JCR*, and *SJR*

We matched journals from *Ulrichs* 2013 with journals from the *JCR* 2013 list and *SJR* 2013 list using the journal title and ISSN, and discovered that there are 9488 *JCR* journals and 15330 *SJR* journals out of 36442 refereed academic journals in *Ulrichs*. Additionally, we further discovered that 9030 *Ulrichs* Journals are listed in both *JCR* and *SJR* lists, and 15788 *Ulrichs* journals are listed in either *JCR* or *SJR* lists. This demonstrates that approximately 57% of journals do not have a strong enough impact to reach *JCR* or *SJR* databases, 43% have enough impact to get collected in the *JCR* or *SJR* list (Scopus), and only 26% of journals have a relatively higher impact to reach *JCR* list. This quantitative relationship is shown in Figure 10. The collection of a journal title in more than one repository suggests that the reach of these publications may be higher, thus encouraging targeted activity by academics.

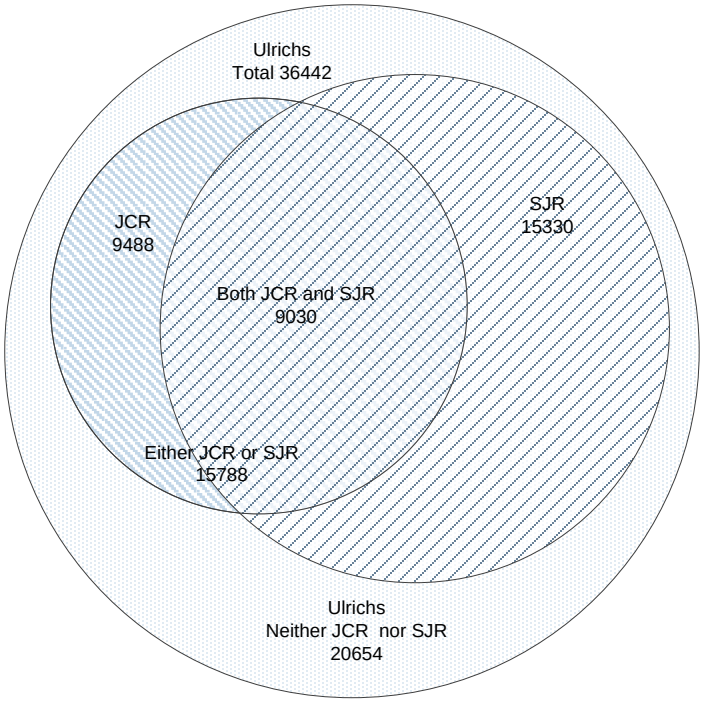

Fig. 10 Quantitative relationship among *Ulrichs*, *JCR* and *SJR*

Impact for *Active* vs. *Inactive* journals

To understand the impact difference between *Active* journals and *Inactive* journals, we compared Active / Inactive SJR and JCR journals. Firstly, we counted the number of *Active SJR* journals, *Inactive SJR* journals, *Active JCR* journals, and *Inactive JCR* journals from 1986 to 2013. We then exacted the sum of *SJR values* for *Active SJR* journals, *Inactive SJR* journals, *Active JCR* journals, and *Inactive JCR* journals from 1986 to 2013. Lastly, we calculated the average *SJR values* for *Active / Inactive SJR* and *JCR* journals from 1986 to 2013 by year. The calculation equation for average *SJR value* is

$y = \frac{x}{x_1}$ where x represents the sum of *SJR values* in Year X and for particular type of journal while x_1 represents the count of particular type of journal in Year X;

As a result, we have four sets of data. They are: average *SJR values* for *Active SJR* journals; average *SJR values* for *Inactive JCR* journals; average *SJR values* for *Active JCR* journals; and average *SJR values* for *Inactive JCR* journals. The data is displayed in a line graph as shown in Figure 11.

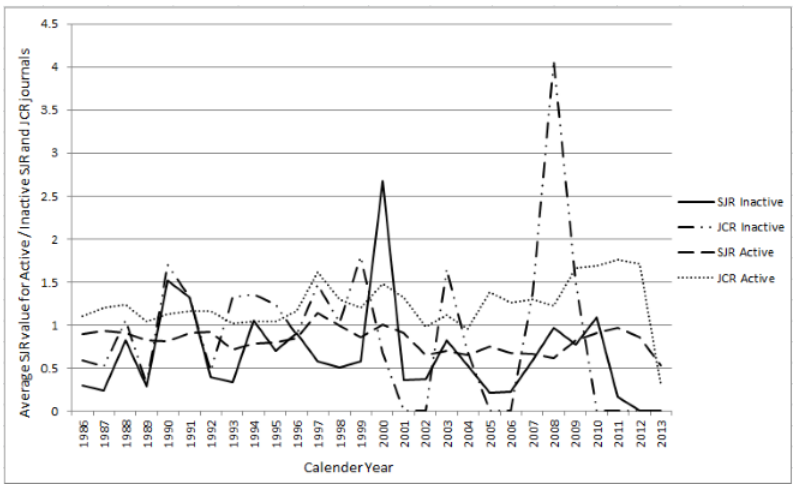

Fig. 11 Average *SJR value* for *Active* / *Inactive SJR* and *JCR* journals by year

Figure 11 shows that *Active JCR* journals have higher *SJR values* than *Active SJR* journals, which aligns to the analysis results shown in Figure 10. It is also evident that the *SJR values* for *Active* journals are more stable than the *SJR* values of *Inactive* journals over time. The reason for this is that there are more *Active* journals in number, and the sum of *SJR values* between years is stable. The number of *Inactive* journals by years is very limited, therefore the changes shown on the graph are more variable. For example, in 2008, there were only two *JCR* journals that ceased publishing. The sum of *SJR* values for both *JCR* journals are more than 8. As a consequence, the average *SJR value* for *Inactive JCR* journals in 2008 is more than 4. In the same year, there are 108 *Active JCR* journals with a total *SJR value* of 132. This results in the average *SJR value* for *Active JCR* journals being more stable.

To easier compare the impact of *Active* and *Inactive* journals, we calculated the average *SJR values* for *Active* and Inactive *SJR* and *JCR* journals across all years from 1986 to 2013. The results are displayed in Table 5.

	Active	*Inactive*
SJR Journal	0.81	0.65
JCR Journal	1.23	0.89

Table 5: Average *SJR value* for *Active* / *Inactive SJR* and *JCR* journals from 1986 to 2013

From the data listed in Table 5, it can be seen that *Inactive* journals have lower *SJR values* than *Active* journals, and regardless *Active* or *Inactive*, *SJR* journals have lower *SJR values* than *JCR* values. The analysis result suggests that lower impact journals have a higher chance to become Inactive than higher impact journals.

RQ4: Have factors, such as technology and the Internet, changed the distribution format of journals?

Distribution format

A number of different methods were used to distribute journals and their scholarly contributions to the reader audience. Based on *Ulrichs* data obtained on 27 February 2015, there are 11 distinct types of distribution format, including: Print, Online, Microform, CD-ROM, Email, LooseLeaf & Print, Audio, Large Type & Print, Braille, LooseLeaf & Online, and Video. Print (54790), Online (39717), Microform (7858), and CD-ROM (1407) account for 99.4% of all distribution formats (104410). Approximately 90% of journals have one or two types of distribution format, with 54.3% journals have only one type of distribution format, and 35.3% journals have two types of distribution format. Very few journals have multiple types of formats, as shown in Figure 12.

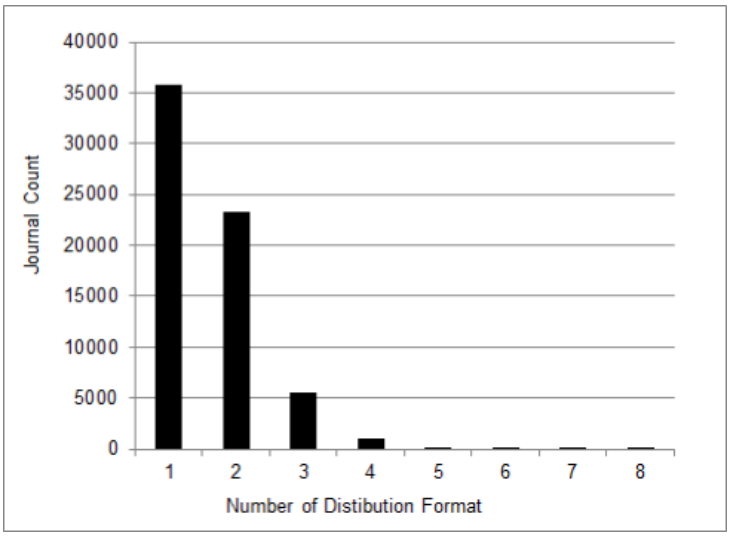

Fig. 12 Number of distribution formats used by journals

Print vs. *Online*

Since the 1990s, with the introduction of Internet, the academic publication system has undergone considerable change (Tenopir & King, 2009). One of the major changes that has occurred is the increase in the number of online journals (Björk & Hedlund, 2004). Additionally, the emergence of university ranking systems in 2002 refocused both institutional and individuals attention to publication metrics (Hazelkorn, 2009). Citations appear as a key metric, and online journals have been shown to increase citation numbers (Harnad & Brody, 2004). As well as economic factors affecting all print-based media (Statzner & Resh, 2010), citations, and the removal of technological barriers to online publishing, act as drivers for a change in the distribution channels of academic journals. To further consider the impact of these factors on the distribution format of journals, we compare the proportionate use of online distribution to print distribution over time. From *Ulrich's Periodical Directory* dated on 27 February 2015, we extracted the journals with *Print-Only* distribution, *Online-Only* distribution, and *Print & Online* distribution. The data is displayed in a line graph as shown in Figure 13.

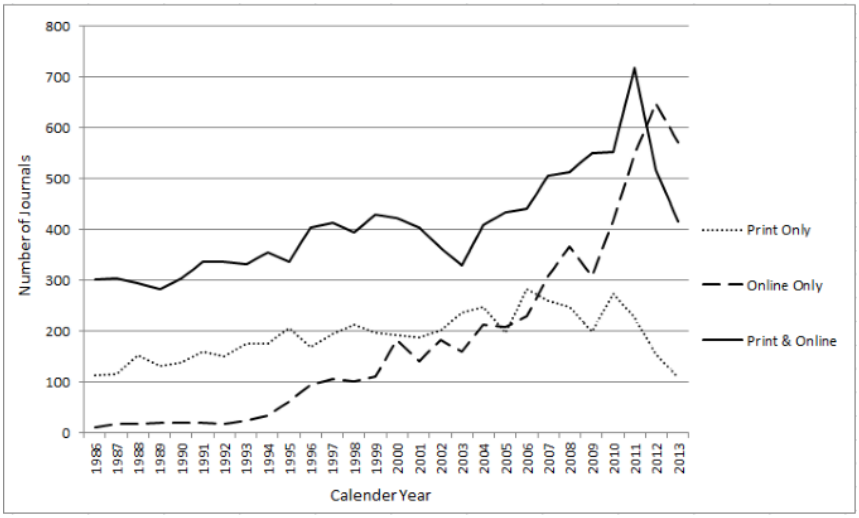

Fig. 13 Number of *Print-Only*, *Online-Only*, and *Print & Online* Journals based on *Newly Created* journals from 1986 to 2013

From the above graph, it is shown that the number of *Online-Only* journals has soared dramatically since 1993 until 2012, and then slightly dropped in 2013, while the number of *Print-Only* journals has remained comparatively

stable over time until 2011. The number of Print & Online journals has grown steadily along with *Online-Only* journals, although at a slower pace since 2011. In 1986 there were 113 *Print-Only* journals, 9 *Online-Only* journals, and 301 *Print & Online* journals, while in 2007 there were 259 *Print-Only* journals, 307 *Online-Only* journals, and 507 *Print & Online* journals. From Figure 13, it can be observed that the number of *Online-Only* journals exceeded the number of *Print-Only* journals in 2007, and the number of *Online-Only* journals also exceeded the number of *Print & Online* journals in 2012. Based on the growth rate calculation method, six growth rates are calculated.

After the initial observation, we studied the growth rates. We calculated the growth rates of *Print-Only*, *Online-Only*, and *Print & Online* journals. The calculation equation for growth rate is:

$y = \frac{x - x_1}{x_1}$ where x represents the number of particular type of journals in latter year and x_1 represents the number of particular type of journals in earlier year;

During the period from 1986 to 2007, the growth rate for *Online-Online* journals is 3311%; the number of Print-Only journals has increased 129%, while the number of Print & Online journals have increased 68.4%. The year 2007 is a milestone in terms of the ratio between Print and Online, whereby the number of Online Only journals exceeds the number of Print & Online journals. During the period from 2007 to 2013, the growth rate for *Online-Only* journals is 86%, whereas the number of *Print-Only* journals has decreased 59%, while the number of *Print & Online* journals has decreased 18%. To further explore this, we calculated the ratio between *Print-Only* and all *Newly Created* journals, *Online-Only* journals and all *Newly Created* journals, and *Print & Online* and all *Newly Created* journals over time for each particular calendar year (Figure 14).

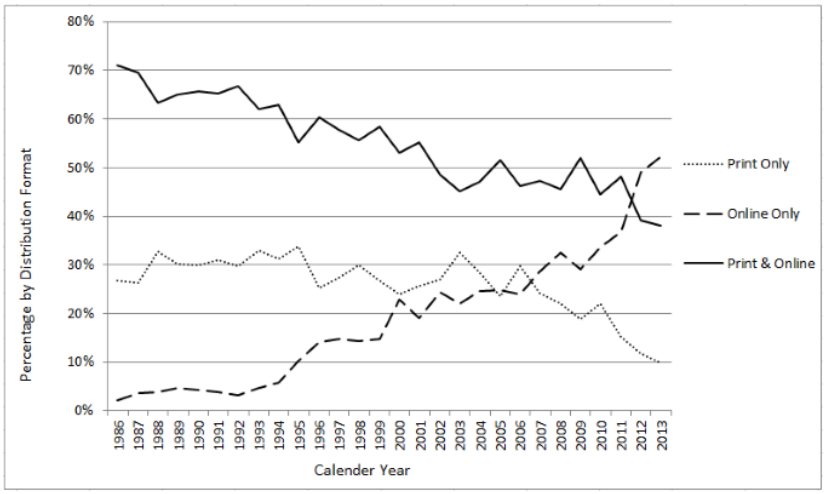

Fig. 14 Ratio between *Print-Only*, *Online-Only*, and *Print & Online* journals of *Newly Created* journals from 1986 to 2013

As a result, we discovered that the number of *Print-Only* journals and the number of *Print & Online* journals have gradually decreased each year, while the corresponding number of *Online-Only* journals is gradually increasing. It can be observed that there is a sign of stabilization in the number of Print & Online journals from 2002 to 2012. As shown in Figure 14, the growth of *Online-Only* journals exceeds the growth of *Print-Only* journals in 2007, and a second milestone occurs when the growth of *Online-Only* journals exceeds the growth of *Print & Online* journals in 2012. Our data analysis in this section only considers up to and including 2013, as the reliability of data from 2014 cannot be ascertained due to potential lag in the data. Unfortunately, information on the potential timeframe for data lag is not available and therefore cannot be ruled out as a potential cause for this deviation.

Open access

A number of studies have been conducted to measure the impact of *Open Access* journals. The results are contradictive. Some studies, including one study from the Institute for Scientific Information, have reported that traditional journals and *Open Access* journals have similar citation impact factors (Pringle, 2004), but other studies suggest there is a slightly higher impact for journals with *Open Access* (Hajjem, Harnad, & Gingras, 2006; Harnad & Brody, 2004). In this study, our focus on *Open Access* is the quantity change in *Open Access* journals. To

consider these changes, we extracted *Ulrichs* journals with *Open Access* and calculated the percentage of *Open Access* journals compared to *Newly Created* journals. The data is displayed in a line graph as shown in Figure 15.

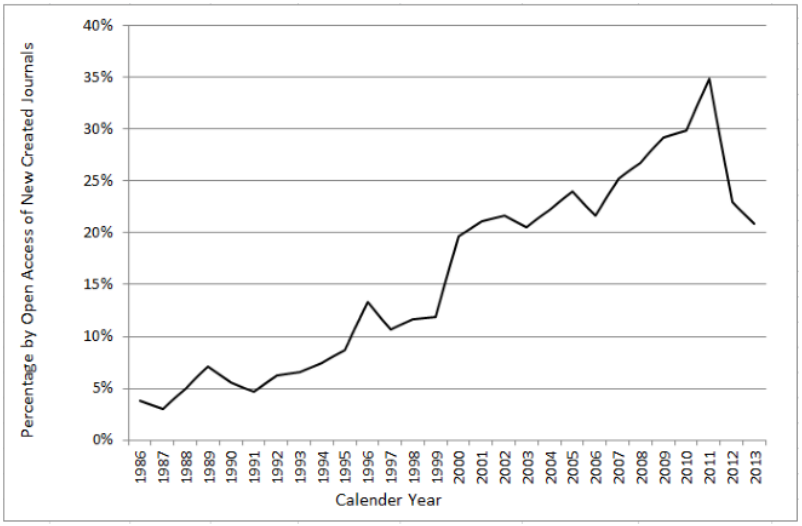

Fig. 15 Proportion of *Open Access* journals to *Newly Created* journals from 1986 to 2013

It is easily recognizable that there is a dramatic increase in the proportion of *Open Access* journals compared to *Newly Created* journals from 1999. In 2011, more than 30% *Newly Created* journals provide *Open Access*. However there is a sudden drop in the number of *Open Access* journals in 2011, which could be related to the data lag discussed in the previous section.

Online and *Open Access* distribution formats are two major indexes to measure Internet usage in the academic publication system. From the analysis conducted in this research, it is obvious that there have been substantial increases in the number of *Online* and *Open Access* journals. It can be concluded from this that Internet technology has played a major role in the changes in the distribution format of journals.

Conclusion

In this paper, we have presented results of the analysis of journal data to answer questions relating to the growth, survival, impact and distribution of journals over the period from 1986 to 2013. A number of interesting patterns emerge from the results presented in this study. Firstly, academic journals grew at an average rate of 4.7% from 1986 to 2013, which is aligned to the 4.68% growth rate during the *Big Science* period from 1944–1978 that was observed by Mabe & Amin (2001). From this, it can be hypothesized that we are experiencing the second journal growth boom period in history.

Secondly, the life cycle of academic journals has been analyzed based on the status of a journal as being *Active* and *Inactive*. During the period 1986 to 2013, academic journals listed in Ulrichs had an estimated 92% *Active* rate, and corresponding 8% *Inactive* rate. Out of those academics that were classified as *Inactive*, 88% were identified as *Ceased*, 10% were *Merged*, and 2% were *Suspended*. It can thus be summarized that only 10% of *Inactive* journals merged with other journals and stayed in the industry, while the remainder ceased business operations. Timing wise, the number of *Newly Created* journals becoming inactive increases substantially in the 1-4 year period after commencement, and reaches a peak in the fourth year. This perhaps suggests a critical survival period exists for journals, which may be useful when considering strategic publication options.

Thirdly, journal impact can be readily measured from the bibliographic database collections. Based on our study of the relationship among *JCR, SJR, and Ulrichs*, it is concluded that the *JCR* journals have a higher impact than *SJR* journals, while *SJR* journals have a higher volume than *JCR* journals. Approximately 43% of *Ulrichs* journals have a high impact and thus are able to reach *JCR* or *SJR* databases, and 26% of *Ulrichs* journals have a relatively higher impact, being collected in the *JCR* database. The fact that a journal listed in *Ulrichs* has a higher probability of being indexed in both major bibliographic databases indicates that this resource provides a good, general indicator

of quality. The comparison results of *Active* / *Inactive SJR* and *JCR* journals suggest that lower impact journals have a higher chance to become Inactive than higher impact journals.

Lastly, the distribution format of academic journals to the reader audience has undergone dramatic changes. With the wide use of the Internet in academic science, the number of *Print-Only* journals is decreasing while the number of *Online-Only* journals is dramatically increasing. In 2007, the growth of *Online-Only* journals exceeded the growth of *Print-Only* journals. More than 30% *Newly Created* journals provide *Open Access* facilities. From this part of study, it is concluded that Internet technology is having a strong impact on the usage of journals.

Although we have considered results from previous work, there are difficulties in comparing our results to those of earlier studies. The fact that the dynamic nature of digital repositories, and the way that these information sources store and maintain data on historic journals, makes repeating analysis done at an earlier time point difficult, if not impossible. This occurs because current records do not have an accurate change tracking history.

Additionally, it is worth mentioning that *Ulrichs* displays the journal data records based on the unique ISSN on the Internet. One journal may have one or many ISSNs based on the distribution format, such as online, print, CD-ROM, and so on. Therefore, each journal may have one or many *Ulrichs* records. This means that journal records are duplicated in the online bibliographic system due to the distribution format via ISSN. As a result of this, the figure of 57,736 *Ulrichs* journal titles, recorded in November 2011 by Tenopir and King (2009), may include journals with individual distribution formats / ISSNs that are counted individually (i.e. online and print format for a single journal counted as two).

In total, 33,000+ peer-reviewed academic journals are included in this analysis, which is an impressive amount of academic heritage. Investigation is required to test the completeness and accuracy of *Ulrich's Periodical Directory*. Further work can also be done to explore the relationship between journal impact and distribution format, and the relationship between journal impact and open access. Most importantly, it is worth continued exploration of historical changes in academic journals over time, including journal impact, number of publications, distribution format, and other influential factors. Better understanding of these patterns may assist in future planning and development at both institutional and individual levels.

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