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A scientometric look at calendar events

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ABSTRACT

Using an application of scientometric methodology to the analysis of scientific communication, relationships between number of submissions of scientific articles and calendar events (e.g., festive seasons, *weekend vacations*, national public holidays, Chinese New Year, *Christmas*) are examined quantitatively. With regard to the aim of understanding the complexities of these relationships, the time series include weekly, monthly, and seasonal variations on the basis of *Received Date* as reported on the *Article History* of the Elsevier paper format. Data records are collected during twenty-year (1990–2010) and one-year periods – as case study – ended 31 December 2008. The analysis shows that the overall submission rates are strongly influenced by calendar events.

1. Introduction

Everyday, hundreds of scientists in all branches of sciences present their research results as original manuscripts to a peer-reviewed journal to disseminate their results to the international scientific community. This happen everyday in the world of science, but the overall events are not cognitively linked on a daily basis with the calendar events.

The presence of calendar effects – particularly *seasonality effect* – has extensively been discussed in literature for the last decade. In practice, it is known that the effect of calendar is a well-studied topic in social (Ajdacic-Gross, Bopp, Ring, Gutzwiller, & Rossler, 2010; Laverty & Kelly, 1998; Rock, Judd, & Hallmayer, 2008; Schwekendiek, 2009), psychiatric (Kurbat, Shevell, & Rips, 1998; Tsai & Cho, 2011), epidemiologic (Walter, 1994), environmental (Zhang et al., 2010), mathematical (Leontitsis, 2003), geophysical (Guglielmi & Zotov, 2007; Jones, New, Parker, Martin, & Rigor, 1999), pharmaceutical (Lee, Yang, Huang, Liu, & Chen, 2006), management (Mantin & Koo, 2010; Su, Lin, & Liu, 2012), zoological (Hazra, Sinha, Mondal, & Khan, 2012; Styrsky, Berthold, & Robinson, 2004), medical (Young & Hade, 2004), applied energy system (Apadula, Bassini, Elli, & Scapin, 2012) and financial (Al-Hajieh, Redhead, & Rodgers, 2011; Almudhaf, 2012; Bley & Saad, 2010; Chong, Hudson, Keasey, & Littler, 2005) sciences. In addition, the relationships between lunar cycles and human behaviors have long been the subject of conjecture (Foster & Roenneberg, 2008; Schafer, Varano, Jarvis, & Cancino, 2010). By contrast, calendar *effects* have not been systematically studied using scientometric methods. The purpose of this paper is to fill this gap in literature and at the end to answer at the following question: How much does the calendar influence the dissemination of the scientific research?

In particular, the aims of this paper are (1) to analyze the time relations of article submission profiles – as notified to the authors from Elsevier journal editorial process – in order to reveal any long- or short-term trends and (2) to assess (if possible) the daily, weekly, monthly and seasonal variability with 1 day resolution. Here the choice of using the submitting date (or *Received Date*) derives from the need for a reasonable time analysis resolution and because – according to Mallig

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(2010) – *this date is much closer to the period in which the work was actually performed than the publication date*. The essence of Mallig's arguments is that a typical scientific article *contains the date when it was submitted by the author and received by the journal* (Mallig, 2010) and this information is interesting and useful to solve the postulated problems. In fact, one important point to retain here is that t*he time resolution in the present analysis is one* day; therefore a higher accuracy would be expected. To my knowledge, it is the first time that a high-resolution search approach for the time series analysis is applied to the scientific literature from a scientometric perspective. Therefore, systematic investigations of the daily properties of submissions of scientific articles as a whole can be very useful for better understanding of the scientometric analysis itself and its applications. In other words, find these relationships and answer to above question are not merely an intellectual-time-waste-exercise in editorial management, but more importantly an element in efficient bibliometric database utilization, that can have a significant impact on the scientometric measures and time series indicators.

2. Collection of data and methodology

For the purposes of this paper, the author examines the number of submissions of scientific articles in the Elsevier's electronic platform ScienceDirect® (www.sciencedirect.com) as a whole. ScienceDirect® database selected is sufficiently representative of the world situation in all its complexity because it covering the full texts of all articles in journals published by Elsevier. Here the term "scientific articles" refers to the journals covered by the ScienceDirect®. To explain more clearly, in this research scientific articles are defined as regular scientific papers printed in Elsevier's journals, with the *date when it was submitted by the author and received by the journal* (Mallig, 2010). Data collection was performed in June 2012 and the selected scientific papers are exported for further time series analysis. The authors searched the published English-language peer-reviewed literature in the advanced ScienceDirect® search interface. All books are excluded from the analysis.

As mentioned above, time series were generated exclusively using the data reported in the first page of the selected scientific papers in agreement with Mallig's view (Mallig, 2010). In particular, input data for the time series analysis are given by the corresponding Article History of each article in the Elsevier paper format using two time windows appropriate for different aims. Consequently, the present study is restricted to scientific articles published (1) from 1990 to 2010 and (2) one-year periods – as case study – ended 31 December 2008. Here a common year is 365 days. To help us with the qualitatively analysis of relationships (if any) between the number of submissions of scientific articles per day and holidays – defined as differences in number of scientific papers between holiday and non-holiday periods – calendar periodicities (monthly and seasonal variables), Christmas Day (celebrated generally on December 25 of each year) and the first day of the year on the modern Gregorian calendar (New Year's day on 1 January of each year), the author uses a twenty-year time-series data set from 1990 through 2010 (7670 days). A ScienceDirect® search for 365 items with the keyword from "Received 1 January" to "Received 31 December" (365 queries), published during the period 1990–2010 returned 660,191 documents. Generally, in this series it can be expected that there is no distinction between week day and weekend because its randomize contribution (in rotation each year for 20 consecutive years) to the twenty-year range is really modest.

On the other hand, the analysis of weekly periodicities is another valuable tool to understand the calendar impacts on the number of scientific articles per day produced around the world. To this aim, a second data collection period is confined to the papers published in the year 2008 in journals covered by the ScienceDirect®, and involved the extraction the number of submissions of scientific articles per day for a selected period of time from "Received 1 January 2008" to "Received 31 December 2008" (366 queries) in all text that were indexed in the database. By applying this research strategy, in ScienceDirect® the author got 7529 scientific papers in the target time of 1-year. In this case, the weekday-weekend parameter does not limit but extend the new time series sets for daily timescales (2008).

At the end, to study the relationship between national holidays (i.e., Chinese New Year) and number of submissions of scientific articles in more detail, another partial case study was conducted on scientific papers with the ScienceDirect® query field from "Received 1 January 2008" to "Received 31 March 2008" and "China" name as Affiliation Country (91 queries). The author chooses the Chinese New Year as a case study because it is the most important of the traditional Chinese holidays for more than 1.3 billion people. Chinese New Year falls on different dates each year between January and February. In particular, it would fall on February 7th, 2008. When applying these strategies the author found out 498 scientific papers submitted from China in the three-month window period. In first approximation, this last time series is representative of scientific productions all across China in the selected period and submitted to an Elsevier Journal.

We note that this processing of the "received data" involves some choices that may be subject to criticism from someone. For instance, one may argue that not all Elsevier publications reported clearly this type of information and virtually all manuscripts were submitted to journals for peer review, but most of them were rejected (Egghe, 2012). In both cases, the limiting factor is the lack of the date of submission. Moreover, other critics can argue that the magnitude of the public holiday effect (i.e., Chinese New Year or Christmas) depends also on the cultural background of scientists. Although not perfect, the role of calendar on the scientific productivity becomes easier to identify. Preliminary results of this work and some empirical notes are described in the next section of this study.

3. Results and discussion

This section examines calendar effects on the number of submissions of scientific articles in Elsevier publications with the date of submission of the paper.

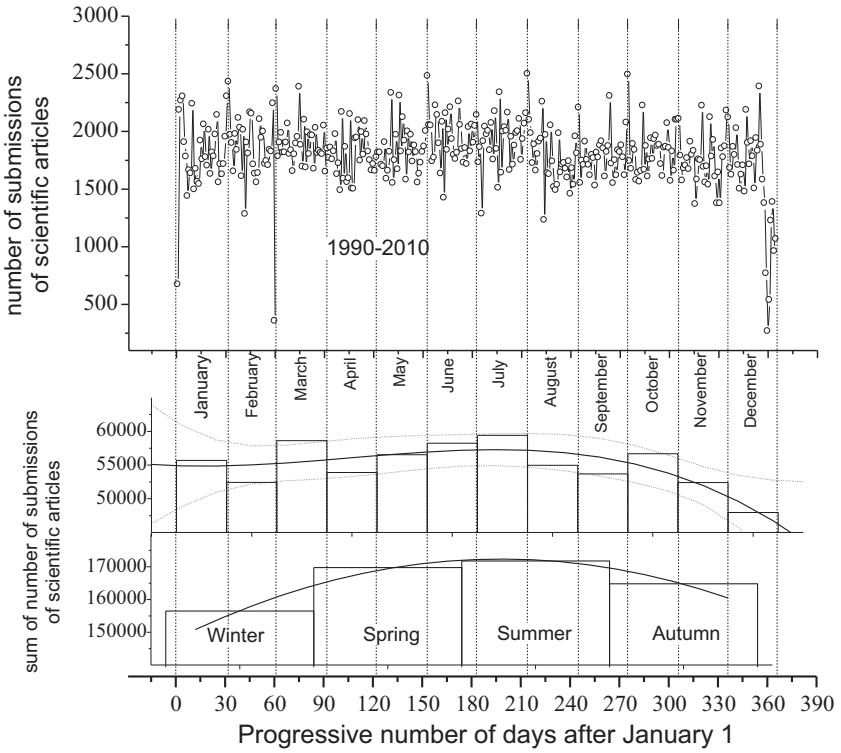

Fig. 1. (Top) Daily count of scientific paper profile obtained from 1 January to 31 December in the time series 1990–2010. (Bottom) Global number of submissions of scientific articles on the monthly and seasonal timescale relative to 1990–2010.

The diagram at the top of Fig. 1 illustrates the globally scientific papers in the period from 1 January to 31 December in the selected twenty year range (1990–2010). From experimental it was observed that the time serie data remains almost constant through time until the end of December, mainly associated with the overall progressive growth in the number of submissions of scientific articles in the selected database. On this large time scale, the series shown agree with most recent analysis.

In the twenty-year period from 1990 to 2010, the average number of submissions of scientific articles per day was 86.07. The highest numbers of papers was submitted in 1st June (2477), 1st August (2495) and 1st October (2489). The minimum numbers (264) were occurred on 25 December 2008, whereas February 29 (352) is a date that usually occurs every four years (such as 1992, 1996, 2000, 2004 and 2008).

The bottom of Fig. 1 shows the two timescale series by month and season of global number of paper average relative to 1990–2010. The minimum and maximum numbers of submissions of scientific articles were occurred in December and July with 47,976 and 59,427, respectively. Total monthly papers were also increasing in March (58,619) and June (58,246). Moreover, the monthly means of total published paper rates were 1796.9, 1872.1, 1890.9, 1796.5, 1824.2, 1941.5, 1917.0, 1773.4, 1789.4, 1828.5, 1746.7, 1547.6, for January, February, March, April, May, June, July, August, September, October, November and December, respectively.

Change in the seasonality of number of submissions of scientific articles was manifested in the present study. As it is clear in the bottom of Fig. 1, the number of submissions of scientific articles appears to increase up to time of the spring-summer and decrease in autumn-winter seasons. For example, academic summer vacations coincide with this productive period because the university is normally less busy during these months and then, for many academicians this mean more time to write and submit scientific papers to the journals. The calendar effect is a complicated phenomenon but the presence of these summer anomalies suggests the existence of a global phenomenon. These results confirmed findings from other studies in different branches of sciences that showed that the relationship between calendar and behaviors was stronger than previously believed (Ajdacic-Gross et al., 2010; Al-Hajieh et al., 2011; Almudhaf, 2012; Apadula et al., 2012; Bley & Saad, 2010; Chong et al., 2005; Foster & Roenneberg, 2008; Kurbat et al., 1998; Laverty & Kelly, 1998; Mantin & Koo, 2010; Rock et al., 2008; Schafer et al., 2010; Schwekendiek, 2009; Su et al., 2012; Tsai & Cho, 2011; Young & Hade, 2004).

The results obtained up to now show an evident relationship between the months of the twenty-year time series (1990–2010) and the number of submissions of scientific articles to Elsevier Science Ltd in its several scientific journals. But, the potential for novel investigation, improved the resolution level 1-day, is illustrated in Fig. 2(A), which is a real time series during the year 2008 of submitted scientific papers by the author and received by the journal. In short, the effect

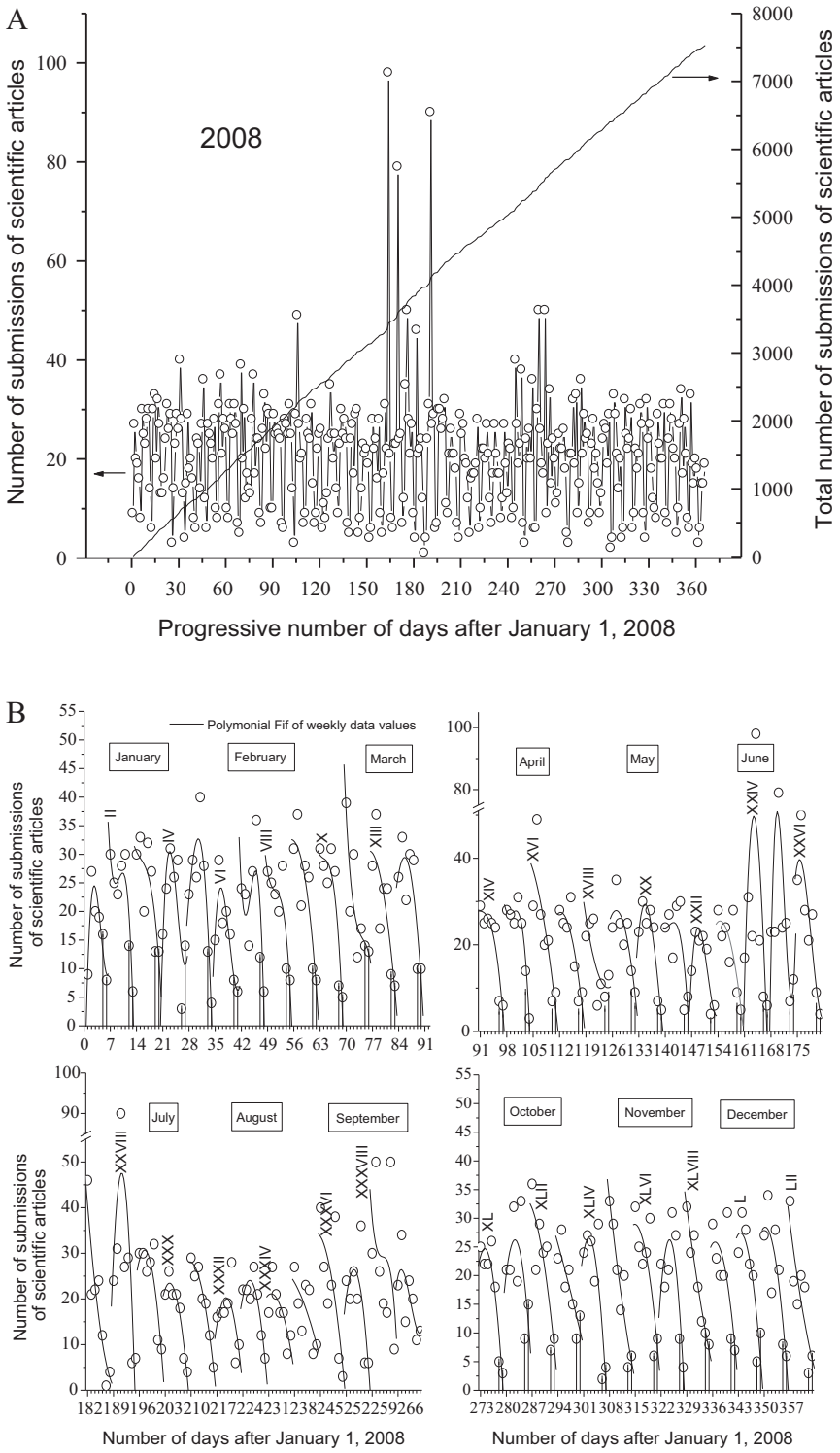

Fig. 2. (a) Daily count of scientific paper profile measured in the ScienceDirect® database from 1 January to 31 December 2008. (b) Weekly cycle of number of submissions of scientific articles. The vertical lines indicate the weekends. The Latin numbers indicate the corresponding weeks from I to LII.

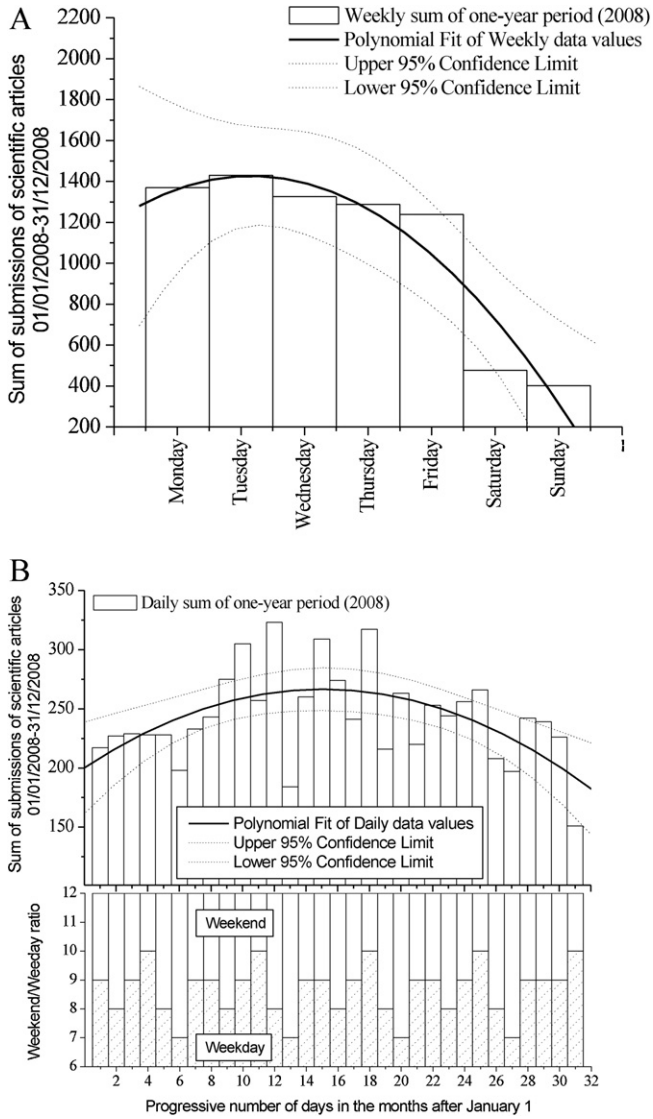

Fig. 3. (a) Sum of weekly submission rate of number of scientific articles and (b) days of months from 1 January to 31 December 2008.

of the week variables becomes more evident when number of submissions of scientific articles for the individual days is considered along 1 year (i.e., 2008). Consequently, the influencing of weekend variables has been evaluated during a 1-year period ended 31 December 2008. As Fig. 2(A) shows, there is no doubt that scientific papers are growing in numbers but a strong cyclic week pattern is superimposed on growth trend, mainly correlated with the publishing activities throughout the week.

In the present study, scientometric analysis reveals some surprising results. Fig. 2(B) shows clearly the modulation of scientific papers activity with a period of 7-days. These figures were derived by superposition of 52-weeks (I-LII) with duration of 3 months for each diagram and the vertical lines indicate the weekends. The weekend-weekday effect depends an individual country's working and non-working lifestyle, degree of industrialization, or religious and cultural background, so it may not be consistently observed everywhere in the world (Tan, Chou, Liang, Chou, & Shiu, 2009) but the negative peaks in Saturday and Sunday clearly reflect the reduction of the overall submission activity during the weekends (Fig. 2(B)).

To examine the weekend effect over the weeks under investigation (see I-LII in Fig. 2(B)), the weekly total of number of submissions of scientific articles was plotted. Fig. 3(A) shows the variation in the sum of scientific paper for different days of I-LII weeks from Monday to Sunday. Over the whole period of 1-year investigation, the results give strong evidence of a weekend effect (Saturday and Sunday) on the number of submissions of scientific articles and a marginally significant evidence of weekday effect from Monday to Friday. This scientific activity, during the weekday, is almost 7 times higher than the sum of papers in the weekend during 2008. Note that, as it seems intuitively reasonable that at weekend the submitted paper should be low in numbers, the polynomial fitting line in Fig. 3(A) has the maximum through the Tuesday.

Fig. 3(B) shows a visual correlation between the number of submissions of scientific articles over a 1-year period (2008) and the day of month (1–31). Notice that there is a relationship between the submission events that occur in twelve months and the monthly calendar; so that the sum of papers can be approximated at a series of 12 points by a 2nd order polynomial in time. The number of submissions of scientific articles comparison during a period of 31 days for twelve consecutive months reveals other unexpected results (Fig. 3(B)). One surprising result is that, from a statistical point of view, some authors prefer to submit their results to the international journal more often around the middle of months than in month boundaries. As the readers can see at the bottom of Fig. 3(B), in general the calendar exhibits a repeating pattern for the ratio between the weekdays (work days) and the weekend events during 2008, but, by contrast, the maximum values of number of submissions of scientific articles are observed at 10th, 12th, 15th and 18th of the month. While, the minimum values were observed at 6th, 13th 27th and 31st of the month where the weekday/weekend ratio is 1.4. As we did not find other study about the effect of calendar to number of submissions of scientific articles in the scientometric literature, the results of the present study could not be compared with any other study. Several possible interpretations come to mind but the only possible explanation is that most of the scientific projects ended at the end of every single month so that the percentage of submissions was found higher during central days of month. The reported behavior is not easy to understand and so, further studies are recommended in order to clarify the influence of the days of the month on number of submissions of scientific articles.

Christmas is one of the most important Christian celebrations and there are over about 2.1 billion Christians in the world. On the other hand, the purpose of choosing the *Chinese published* papers during the Chinese New Year event as the study

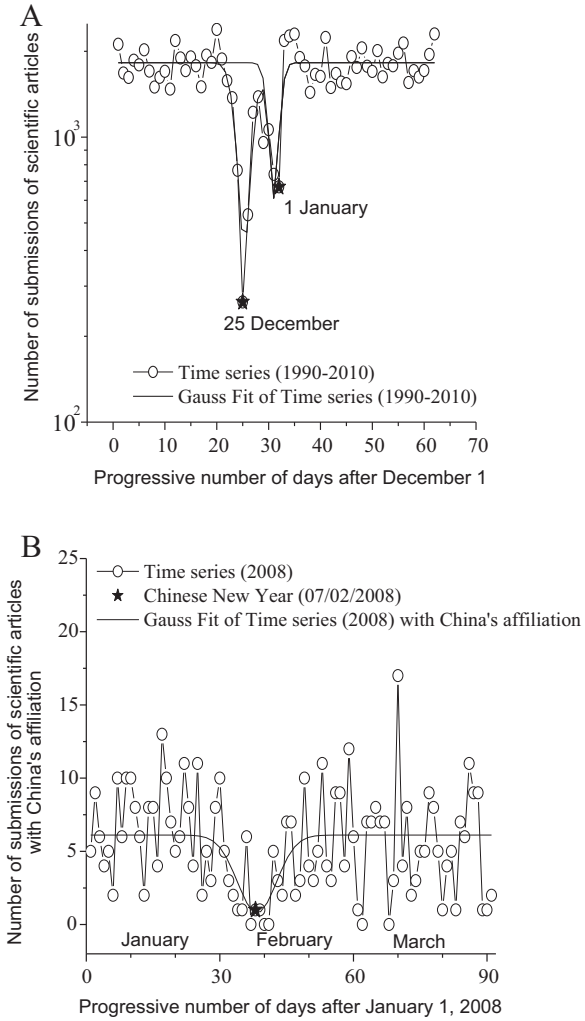

Fig. 4. (a) Daily count of scientific paper profile measured in the ScienceDirect® database from 1 December 2008 to 31 January 2009. The tie series can be deconvoluted into two Gaussian components peaked at 25 December and 1 January, attributed to Christmas and New Years period, respectively. (b) Daily count of scientific paper profile measured in the ScienceDirect® database from 1 January to 31 March 2008. The time series can be modeled by one Gaussian distribution peaked at 7 February 2008.

context because the Chinese New Year is the most important among all holidays in China. Since the Christmas and Chinese New Year are found to constitute in a statistical sense two time series of its own (lower number of submissions of scientific articles than the rest of year), these periods are considered as two separate time series. Thus for present section we consider two time series in different period as follows: Christmas (a worldwide time series; as reported in Fig. 1 from 1st December to 31st January 1990–2010) and Chinese New Year (a Chinese time series; as reported in Fig. 2(B) from 1st January to 31st March 2008). For instance, the "start" and "end dates" are set to the appropriate time frame associated with the two selected holiday events. These two dates are the 25th December (fixed date for the celebration of Christmas across the world and time) and 7th February 2008, respectively. It is of interest to observe the submission date of these two time series.

When the time series spectrum is deconvoluted into two Gaussian components, the peak positions and the intensity ratio of the two peaks are consistent with the calendar events. The relationships determined by two Gaussian model fits are shown in Fig. 4(A) for Christmas and New Years period, respectively. The well-resolved peaks are seen at 25th December and 1st January, respectively. The first peak can be attributed to the Christmas holiday, whereas second one represents New Year event. As shown in Fig. 4(A), however, the agreement between fitted and experimental data is not perfect, but sufficient to demonstrate that the average number of submissions of scientific articles during the selected time series is about 86 and 61% higher than that during Christmas and New Years period, respectively. The interval between Christmas and New Year's day has an average papers trend close to that of normal period but with significantly lower frequency of paper per day (−50%). Like the daily case in Fig. 4(A), the daytime papers in China during the Chinese New Year (Fig. 4(B)) shows one peak located at the expected value (7th February 2008). The single peak represents one of the fundamental traditions in China. The magnitude of the public holiday effect like Christmas and Chinese New Year depends on the cultural background of its national scientists but we have found that the contraction on number of submissions of scientific articles is linked to the holidays of the year in the West as the East. None of the previous studies considered daytime and holiday periods.

4. Conclusion

Calendar effect is a concern in almost all branches of sciences (Ajdacic-Gross et al., 2010; Al-Hajieh et al., 2011; Almudhaf, 2012; Apadula et al., 2012; Bley & Saad, 2010; Chong et al., 2005; Foster & Roenneberg, 2008; Guglielmi & Zotov, 2007; Hazra et al., 2012; Jones et al., 1999; Kurbat et al., 1998; Laverty & Kelly, 1998; Lee et al., 2006; Leontitsis, 2003; Mantin & Koo, 2010; Rock et al., 2008; Schafer et al., 2010; Schwekendiek, 2009; Styrsky et al., 2004; Su et al., 2012; Tan et al., 2009; Tsai & Cho, 2011; Walter, 1994; Young & Hade, 2004; Zhang et al., 2010) but to the best of my knowledge this is the first comprehensive study of the impact of the calendar – such as festive seasons, weekend vacations, national public holidays, Chinese New Year, and Christmas – on the number of submissions of scientific articles.

We may summarize the main contents and conclusions of this paper as follows: (1) the calendar effect is an interesting problem that may appear when high resolution analysis is used in scientometric studies. (2) Given a choice, people are less likely to submit a scientific paper during the calendar event and, consequently, calendar may play some part in that decision as a whole.

In conclusion, the answer to our opening question is yes; calendar events strongly influence the daily variability of the scientific research submissions. Practically, this means that the calendar effects may add a new insight to this issue. In one way or another, scientometrists and information scientists are forced to deal with the complexities of the large number of data-related variables. In this light, according with von Bertalanffy (1968), it is necessary to study not only parts and processes in isolation, but also to solve the decisive problems found in organization and order unifying them, resulting from dynamic interaction of parts, and making the behavior of the parts different when studied in isolation or within the whole. This is the context for the observations of the present paper.

The human and cultural factors – from singles to collectives (i.e., birthday day, wedding anniversary, foundation day of an university, national holidays, international workers' day, traditions of religions around the world) – are also responsible for the behavior of scientists and for the individual/collective production of scientific papers, but are often not considered at all, or are inadequately considered. Taking into account a daily time dimension in the scientometric domain are challenging research topics for the future work.

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