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Sleeping Beauties in Innovation Studies

Ana Patrícia Moura Abreu

Supervisors: Aurora A.C. Teixeira and Pedro Cosme Vieira

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Bio

Patrícia graduated in Information Science by the University of Porto (joint course between the School of Arts and Humanities - FLUP and the School of Engineering - FEUP) in 2013, obtaining a grade of 15/20.

She is currently attending the Master Program in Innovation and Technological Entrepreneurship (FEP and FEUP).

Patrícia developed some projects and has presented them in national competitions such as Junior Achievement Program (2013), 3DS Porto (2013) and iup25k (2014). The most significant achievements from those projects were the winning of the 1st place prize at the 3DS Porto contest and the 3rd place prize at the 2014 Social Business Edition of iup25k contest.

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Abstract

A Sleeping Beauty is a publication that goes unnoticed or, as in the fairytale, sleeps, for a long time, and then, almost suddenly, is awakened by a "prince" attracting from there on a lot of attention in terms of citations.

The aim of the present dissertation is to find the SBs in innovation studies and assess which are the reasons behind their occurrence.

In methodological terms, we adapted van Raan's (2004) approach for finding SBs, in order to obtain a method capable of identifying quickly and accurately potential SBs in innovation field.

Through the extraction of 52459 papers from the Web of Science, 7317 of which with 20 citations or over, we were able to identified only 6 SBs, that is, 6 papers that were published ahead of their time. This means that SBs are indeed rare in innovation studies (less than 0.01% of total papers).

The depth of SBs' sleep ranges from 7 years (Kaplan, R.S. and Norton, D., 1992, "The balanced scorecard: measures that drive performance", *Harvard Business Review*) up to 17 years (Damanpour, F.; Szabat, K.A.; Evan, W.M., 1989, "The relationship between types of innovation and organizational performance", *Journal of Management Studies*). All the SBs were published in highly renowned journals – 3 in Harvard Business Review and the remaining in *Journal of Management Studies, Organization Studies,* and the *Rand Journal of Economics*. Interestingly, the papers that awaked the SBs (the Princes), were also published in highly renowned journals but from study areas outside the area of the SB, namely, decision sciences, marketing, innovation management, and policy studies. This finding reinforces the multidisciplinary character of the innovation studies area.

We further uncover that the awakening of some SBs coincide with changes in institutional frameworks and standards (e.g. the publication of amendments on the patent law of the United States in the case of Trajtenberg, M., 1990, "A penny for your quotes: Patent citations and the value of innovations", *Rand Journal of Economics*) or the influence of key related policy making institutions such as the OCED and Eurostat (e.g., the publication of Oslo Manual by OECD/Eurostat in the case of Damanpour, F.; Szabat, K.A.; Evan, W.M., 1989, "The relationship between types of innovation and organizational performance", *Journal of Management Studies*).

Keywords: sleeping beauties, innovation, delayed recognition, flash in the pan, information awakening.

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1. Introduction

Scientific works are the engine of knowledge development leading to significant and growing public and private resources to be allocated to research and development activities (Holsapple and O'Leary, 2009). However, efficient allocation of resources requires that the output of those individuals who are involved in producing science is evaluated (Hawkins *et al.*, 1973). Such evaluation, especially in the basic sciences, is very difficult because it takes a substantial time lag between the publication of 'discovery' and the visibility of this latter's impact on society (Glanzel *et al.*, 2003). To overcome this limitation, an increasing number of institutions use journals' citations as a measure for the value of the 'discovery'. In addition, a reasonable number of studies (Kalaitzidakis *et al.*, 2001; Ma *et al.*, 2013) have been developed in order to assess the 'quality' of publications or its authors based on the number of citations that the publications receive.

The evaluation of the possible relationship between the future impact in the society of the 'discovery' included in the article and the number of citations that the publication receives has focused the attention of scholars in the areas of scientometrics and bibliometrics (Glanzel *et al.*, 2003), who seek to find appropriate forms of assessment, including assessment by peers and number of citations and co-citations (to discover the networks linking authors).

Observing the time path of the number of citations, it has been noted in the literature (van Ran, 2004) that there are articles that initially were "dormant" for several years. This phenomenon attracted a lot of attention especially in science resulting in the emergence of a new concept, 'Sleeping Beauties' (van Raan, 2004). This consists in articles not cited or little cited for a long period of time that suddenly began attracting a lot of attention (*i.e.*, they begin being cited with significant intensity). The reasons for the change in the pattern of citations may include a paradigm shift in the study area (Wang *et al.*, 2012; van Raan, 2004) or, for example, have been written by an investigator who suddenly achieves notoriety, e.g., by winning the Nobel Prize (*e.g.*, Chadwick's physics prize in 1935; Davisson and Germer's physics prize in 1937 and Kapitza's physics prize in 1978, Li and Ye, 2012). However, the explanations for the SB phenomenon are yet under explored (Ke *et al.*, 2015).

In the bibliometrics literature, the SBs are associated with concepts such as 'delayed recognition' (Li, 2014) or 'information awakening' (Wang *et al.*, 2012). The term SB was first used by van Raan (2004), but this phenomenon, using a distinct terminology, it has been already previously discussed by Garfield (1980) and Glanzel *et al.* (2003).

'Sleeping Beauties' are relatively rare (less than 0.1% of the total published papers) but, even so, a very common phenomenon in Sciences (Wang et al., 2012). They have been mostly analyzed in Sciences related literature (van Raan, 2004).

The empirical evidence shows that SBs are usually of great value to science (Hu and Wu, 2014). Some studies showed that SBs, namely those associated to Nobel Prize Laureates, (Li and Ye, 2012; Li, 2014; Li *et al.*, 2014) were firstly ignored by fellow scientists. It is argued that those papers, if accepted earlier by peers, would have contributed to a faster development of science and technology (Wang *et al.*, 2012). Thus, this empirical evidence indicates that the study of SBs is necessary to better understand the reason for their late reconnaissance and the reason why the "information" sleeps (Wang *et al.*, 2012). Moreover, as Ke *et al.* (2015: 1) underline "the study of SBs provides empirical evidence against the use of short-term citation metrics in the quantification of scientific impact.".

Although common in Sciences, in the field of innovation SBs have never been studied or assessed. This study is also relevant because the innovation is considered one of the most important issues in today's business research (Hauser *et al.*, 2006) being "the primary driving force of progress and prosperity" (Volberda *et al.*, 2013: 2). Moreover, as a broad topic, diverse disciplines, namely marketing, quality management, operations management, technology management, organizational behavior, product development, strategic management, and economics, focus on various aspects of innovation (Hauser *et al.*, 2006), which supports the idea that the study of SBs in this field can contribute, even indirectly, to the understanding of the evolution of related areas.

In this context, the present study aims to assess the magnitude of the SBs phenomenon in Innovation studies. By studying the citation profile of potential SBs we intend further to contribute for a better knowledge of the flow of scientific production and practices in this stimulating area of research. To the best of our knowledge, despite the existence of a reasonable number of high quality bibliometric studies in the innovation field (*e.g.*, Butcher and Jeffrey, 2005; Leydesdorff *et al.*, 2013) none has tackled the issue of SBs.

Resorting to a quantitative/bibliometric methodology, we propose an adapted method of van Raan's (2004) approach capable of identifying from thousands of papers quickly and accurately potential the potential SBs. Such an approach is applied to a population of 52459 papers extracted from the Web of Science bibliographic database with 'innovation' as keyword (filtered by 'social science' and 'business economics'), over a long period of time, 1900 to 2015. The 'potential' SBs are then analyzed to find their 'Prince' and figure out the reasons behind their awakening (*e.g.*, eventual change of paradigm in the field or authors' sudden notoriety).

In terms of structure, the present dissertation is organized as follows. In the next section is presented the literature review, followed (Section 3) by a discussion of the methodology. The Section 4 details the results and Section 5 concludes the study.

2. A review of the literature on the sleeping beauties

2.1. Defining sleeping beauties and other related concepts

The term 'Sleeping Beauties' (SBs) refers to a paper that goes unnoticed/ sleeps/getting low recognition in terms of citations for a long period of time and suddenly starts receiving a lot of attention (gets high citations) after being awaken by a 'prince' (the paper that is the cause of the awakening), obtaining a delayed recognition (van Raan, 2004), or, in other words, whose importance is not recognized for several years after publication.[1]

Although rare (less than 0.1% of published papers), SBs are common in science (Wang *et al.*, 2012; Ke *et al.*, 2015), being mostly analyzed in science related literature (van Raan, 2004). In some sense, the literatures advance the conjecture that a SB describes a discovery that is ahead of its time (van Raan, 2004).

Some authors (Burrell, 2005; Ohba and Nakao, 2012; Li, 2014) use the Van Raan's method to identify SBs, resorting to a quantitative analysis of the delayed recognition. Key variables are identified: 1) The '*depth of sleep*', period during which the article receives little attention, either a '*deep sleep*' (an average of at most one citation per year) or '*less deep sleep*' (an average between one and two citations per year) during the sleeping period; 2) The '*length of sleep*', referring to the duration of the sleeping period; and 3) The '*awakening intensity*', that is, the number of citations per year, during the 4 years following the sleeping period (van Raan, 2004).

Van Raan (2004) also applied the 'Grand Sleeping Beauty Equation' with the above variables, which permits to evaluate the "strangeness" of the SB for any sleeping time, sleep intensity and awakening intensity.

Having in mind the information's obsolescence, several researchers concluded that the value of information will decay gradually over time, as well as its usefulness to the society (Gosnell, 1941; Brookes, 1970, in Wang *et al.*, 2012). Then, one particularity of SBs in this regard is that SBs are subjected to a slow obsolescence of publications (Li *et al.*, 2014).

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[1] A related, though opposing concept to SB, is called "flash in the pan", which refers to documents that are noticed immediately after publication, and frequently cited, but do not seem to have a lasting impact and die early in life (Li, 2014).

2.2. Extant literature on sleeping beauties (SBs)

Going from a theoretical to an empirical type of the studies on SBs, we summarize, in the present section, some of the main findings of this literature.[2]

The occurrence of SBs has been studied and it was strengthened the conjecture that it contains an idea ahead of its time that has been set by a lower academic stature young scientist (Liang *et al.*, 2009 in Ma *et al.*, 2013). Other reasons have been pointed out, since SBs have been studied in distinct fields of research, such as Ophthalmology (Ohba and Nakao, 2012) or Virusology (Li and Ye, 2012). In the first field, Ohba and Nakao (2012) concluded that the time needed to confirm and enlarge experience of new diseases and technologies is likely to be relevant to explain the delay in citation recognition of clinical studies.

Being a fact that SBs exist, the process we need to understand is how they can be awakened, and, in this analysis, as important as finding SBs, it is also highly important to understand and find how to or which related paper/issue awake them. For instance, regarding the Virusology field, Li and Ye (2012) disclosed that the rediscovery of a virus starts a virus-theory trend in research, awakening some paper, (SBs), that previously conjectured their existence.

Aiming to understand the phenomenon of SBs, Wang *et al.* (2012) held a qualitative study where they established some basic elements of information utilization as important for information awakening: information value, access channel and user needs/user demand. They contented that the sooner we understand the reasons behind a SB, the faster we can establish a better mechanism to awake them and maximize their value.

Also concerning the awaking of SBs, Li *et al.* (2014) addressing the 'heartbeat spectra' for SBs conclude that publications which possess 'late heartbeats' (most citations were received in the second half of the sleeping period), have higher awakening probability than those that have 'early heartbeats' (most citations were received in the first half of the sleeping period).

For the referred awakening process, a 'prince' is indispensable, because it is the fundamental piece of the awaking process the SB, leading it to attract a lot of attention

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[2] In Appendix we present the supporting Table A1, where it is detailed the surveyed studies, including information on their methodology, findings and main uncovered gaps.

(van Raan, 2004). However, finding a 'prince' is a common difficulty among studies and it is not so easy to decide which paper(s) might be considered the 'Prince(s)' (Kozak, 2013). Kozak (2013) states that it is possible that any type of paper constitutes the 'Prince', namely a conference presentation in which the SB is discovered. This author's position differs from van Raan's (2004) who says that the 'Prince' is the first paper citing the SB. In identifying the 'prince', Ohba and Nakao (2012) found that self-citations play a role of the 'prince' in the SBs. Thus, there is a chance that the author of a SB is also the author of SB's 'prince' (a co-citation).

2.3. The methods to identify the sleeping beauties: An overview

In this challenge of finding SBs, various studies were based on equal or similar methods. Several authors (*e.g.*, van Raan, 2004; Burrell, 2005; Ohba and Nakao, 2012; Li, 2014), based their methods in three main variables – i) 'depth of sleep', ii) the 'length of sleep', and iii) the awakening intensity (*cw*) - and proceeded to a quantitative analysis of delayed recognition (see, Table A1 in the Appendix).

According to van Raan (2004), a SB might be defined as an article that receives an average of at most one citation per year (*deep sleep*), or it gets an average between one and two citations per year (*less deep sleep*) over a minimum period of 4 years (*length of sleep*) and, after this period, it receives a substantial number of citations (*awakening intensity*).

Using those same three variables, Obha and Nakao (2012) took into account a different awakening intensity, considering the total citations per year, during the following 5 years of the sleeping period, instead of the 4 that van Raan (2004) considered. These authors argue that for a paper being classified as SB it has to be cited at least 100 times after its date of publication. Assuming an awakening intensity (*cw*) of 100 citations over a minimum period of 5 years, Obha and Nakao (2012) screened citation histories of 184606 articles in 52 ophthalmology journals using the Science Citation Index-Expanded (Thomson Reuters) and identified nine articles as SBs. Considering the same three variables, Li (2014) studied all the stages of a SB, defining the process as 'all-elements-sleeping-beauties' containing a sleeping period, an awakening period and an happy ending (where both the princess and the prince grow old together ever after the awakening period, since both citation curves synchronously decayed). In order to understand the duration of the sleeping period, Li *et al*. (2014) investigated 58963

papers of Nobel Laureates and applied a Gsindex in order to measure the inequality of 'heartbeat spectrum', which indicates the duration of sleeping period. Heartbeat' refers to the number of citation(s) that each year the SB receives in the sleeping period (Li. et al., 2014).

Earlier Li (2014) presented two remarkable examples to demonstrate that the citation curve of a paper might be characterized by a 'flash in the pan' or a 'delayed recognition'. In other words, the study might be noticed immediately after publication but it did not had a lasting impact ('flash in the pan') or having considerable high recognition only after a (long) sleeping period ('delayed recognition').

A distinct but related method applied by van Raan (2004) is consubstantiated in the computation of the so-called 'Grand Sleeping Beauty Equation' (see Table A1 in the Appendix). This equation provides the number of SBs for any sleeping time, sleep intensity and awakening intensity. This allowed him to conclude that "the probability of awakening after a deep sleep is smaller for longer sleeping period; for a less deep sleep, the length of the sleeping period matter less for the probability of awakening." (van Raan, 2004: 462).

2.4. The relevance of the study of the SBs in Innovation studies

The study of SBs is required in any field to ensure that the academic information remains useful to the society (Wang *et al.*, 2012). This involves the identification of SBs in various areas of knowledge and seeking ways to wake information with potential value to the society that is in a 'sleeping' state. The fact that a given paper receives very few citations after publication and over a relatively long time span and suddenly its citation spurts should be object of an in depth study/analysis rather than be ignored. SBs were proved to be important in science as they can involve new knowledge in form of new or changed paradigms and/or new theories which content is too advanced to be widely grasped (Liang *et al.*, 2009, in Ma *et al.*, 2013) that, if found and accepted earlier, both science and technology would have developed way faster (Wang *et al.*, 2012). Thus, it is highly pertinent to identify and analyze SBs in other fields of knowledge, as their excessive presence may cause idleness and waste of knowledge (Wang *et al.*, 2012).

Having into consideration that innovation is vital for consumers, firms, and countries (Hauser *et al.,* 2006) and that the research on innovation has proceeded in a number of

disparate fields in a variety of disciplines, the discovery of SBs in innovation can contribute to the understanding of the evolution of fields related to innovation, like marketing, quality management, operations management, technology management, organizational behavior, product development, strategic management, and economics (Hauser *et al.*, 2006). It can also give us a notion that regardless the current or short term citation patterns of a given article, there might exist articles ahead of their time, thus researchers, editors and policy makers should not ignore or underestimate the importance of currently low cited papers.

In the innovation area, various scientometric and bibliometric studies exist (*e.g.*, Butcher and Jeffrey, 2005; Leydesdorff *et al.*, 2013) but, to the best of our knowledge, they did not tackle the issue of SBs.

Some scientrometric studies (*e.g.*, Schmoch *et al.*, 2003) worked on relating and suggesting pathways of multiple perspectives of integrated heterogeneous data, where socio-cognitive patterns could later on, serve as signatures of innovation trajectories, trying to track the identification of emerging and developing innovation trajectories. For instance, Leydesdorff *et al.* (2013) analyzed some of these cases and suggested a nonlinear model applied to the use of multiple perspectives to the same data. By focusing on multivariate analysis in various domains and operationalizing it in terms of multiple perspectives, Leydesdorff *et al.* (2013) suggest that such procedure helps to stimulate interdisciplinarity in science, technology and innovation studies.

Aiming at profiling the patterns of research papers, Choi *et al.* (2011) analyzed publications on standards and the corresponding citation data (indexed in the Web of Science database - WoS). They argued that such analysis "may assist policy makers and business executives in the future in distinguishing multiple strategic options and facilitate academia in better understanding and conceptualizing the full impact of standards on innovation" (Choi *et al.*, 2011: 275).

Butcher and Jeffrey (2005) use bibliometric indicators to explore industry-academia collaborations, having into account the conclusions of studies on industry–science relations led by Polt *et al.* (2001), supposing that both universities and public research centers are important as co-operation partners in innovation projects.

This has been a theme widely studied in the past through the exploration or measurement of research collaboration using bibliometric indicators (analysis of

multiple-author or multiple-address publications), such as *coauthorship* (e.g. Qin, 1994) or *citations* (references/citations in papers indicate use of research by others) (Butcher and Jeffrey, 2005). Butcher and Jeffrey (2005) also found out that bibliometric indicators have the advantage of providing information on a country's rate of publishing, including the rate at which their researchers collaborate internationally and changes in collaborative patterns over time. Moreover, they contended that bibliometric data has as a disadvantage as it cannot reveal much, namely about the relationship between collaborators, nor the factors that influence the initiation and ongoing process of collaborative research or how scientists communicated the information (Qin *et al.,* 1997). They therefore suggest that it is better to analyze industry-academia collaborations by combining bibliometric measures with qualitative data.

In the field of innovation SBs have never been investigated. According to Lazzarotti *et al.* (2011), the concept of innovation is in expansion, caused by the largest occurrence of themes like 'resources, abilities and organizational skills, knowledge and learning' and 'innovation management, innovative companies, technological and organizational innovation', which has been lately attracting the most interest from researchers in these areas. Such turbulence is likely to put forward the emergence of some SBs.

Moreover, innovation is often discussed from a wide perspective that involves knowledge, research and development, organizational resources and capabilities. Lazzarotti *et al.* (2011) get to conclude that in recent years, derivate as *dynamic capabilities*, *skills* and *organizational knowledge* have been attracting the interest of academia. With that said, the expansion of the concept of innovation and the fact that it has been attracting attention, render SBs of particular importance. Their study and analysis might enable to understand what have been changing throughout the years and what has gaining attention in the innovation field.

3. Methodological considerations

In order to make a quantitative analysis of SBs in the innovation field, we based our analysis on the bibliometric approach that van Raan (2004), Burrell (2005), Ohba and Nakao (2012) and Li (2014) adopted. This involves computing statistics that aggregates the 'depth of sleep', the 'length of the sleep', and the 'awakening intensity'. As a preliminary step, we compute a statistic similar to the standard deviation to identify among those thousands of papers downloaded from the database Web of Knowledge the few that has potential to be Sleeping Beauties. This step is crucial in the analyses and it is new to the literature.

3.1. Procedure to find the Sleeping Beauties (SBs)

The implementation of the approach that we use in the identification of SBs starts by the gathering of articles published and indexed in the Web of Science with 'Innovation' as keyword, filtered by 'Social Science' and 'Business Economics' classification, over the period 1900 to 2015.[3] The number of papers extracted amounted to 52459.

Because in van Raan (2004) the identification procedure is not explicit, we needed to develop the identification procedure of the 'potential' SBs using three stages/phases.

First, we excluded from the data set all the papers with less than 20 total citations since publication till October 2014. This reduced our database from 52459 papers to 7317 papers. Note that, comparing with Obha and Nakao (2012) who excluded from the analysis those papers that had 100 or more total citations, our analysis is more profound, permitting to identify cases where the awakening intensity is more intense, and turning in this way more challenging to analyze the reasons for the occurrence of the SBs.

Second, we ranked all papers using a statistics similar to a standard deviation by applying the following formula (a temporal horizon of 20 years):

$$K = \left(\frac{\sum_{i=yop}^{yop+20}(i-yoc)^2 noc_i}{\sum_{i=yop}^{yop+20} noc_i} \right)^{0.5} /20,$$

where *yop* is the year of publication and *noc*$_i$ is the number of citations in the year *i*.

This statistics is developed by ourselves, being new to the literature.

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[3] The reference date for extracting the data was October 13th, 2014.

The *K* value has an empirical distribution (see, Figure 1), which permit to identify the SBs among the 7317 papers selected in the phase one.

The SBs candidates will have a high *K* value and, by contrary, the 'flash in the pan' will have a low *K* value. Accordingly, we considered that the SBs candidates will have a *K* value in the interval 0.8 to 1.0.

In a third phase, and only for the identified SBs candidates (with *K* value higher than 0.8), we scanned the reference list of articles citing the SBs and searched for the articles that might act as the 'Prince' (PR) in the process of awakening the SB.
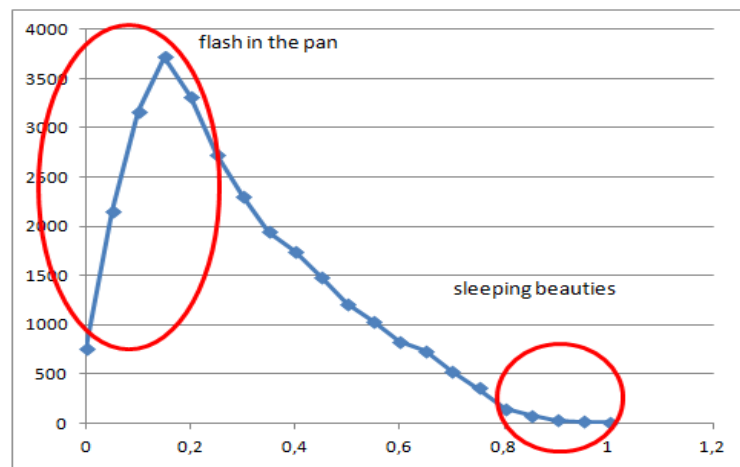
Figure 1: Distribution of the measure K used to identify the SBs candidates, similar to the Log-Normal Distribution

Source: Authors

3.2. Detailed steps for identifying the Prince (PR) using the co-citation pattern

Once identified the paper that had delayed recognition (that is, the Sleeping Beauty, SB) the next stage is to investigate which article (the 'Prince' – PR) triggered the awakening of the SB.

The connection between the SB and the PR will be investigated through the citation pattern. The Prince (PR) cites the SB and, subsequently, there will be SB-PR co-citations (citations involving articles that simultaneously cite the SB and the PR).

Thus, to identify the princes (PRs), we have to complement the time pattern of SB citations with the list of articles that cite the SB and each potential prince. In this task, we only select articles (candidates to be the prince) that have 10 or more citations which mean that it is considered that the prince (PR) has to be a reasonably important article in terms of scientific impact.

The procedure involves 4 main steps:

1) Extract the list of articles that cited the SB and analyze which of these articles are 'potential' princes;

2) Extract the articles citing each of the potentials PRs and analyze the co-citations (SB and Prince);

3) Leaving out all those articles with less than 10 co-citations, and

4) Reduce the subsequent analysis to the "princes" with a large number of citations and co-citations with the SB.

4. Empirical results

4.1. The SBs in the field of innovation

Using the procedure described in Section 3.1., we ranked the 7317 papers selected using the K indicator ($\left(\frac{\sum_{i=yop}^{yop+20}(i-yoc)^2 noc_i}{\sum_{i=yop}^{yop+20} noc_i}\right)^{0.5}$/20). Recall that K has been constructed in a way that results that SBs have a high K value, that is, a $K \in [0.8; 1.0]$.

From the papers selected we were able to identify 6 SB (listed in Table 1). The number of total citations received by each SB (up to October 2014) ranged from 106 (Damanpour *et al.*, 1989) to 1585 (Kaplan and Norton, 1992). The identified SBs were published between the years of 1989 (Damanpour *et al.*, 1989) and 1993 (Normann and Ramírez, 1993; Moore, 1993).

Research quality is often based on journal's impact and this impact is of major importance because it explains both journal's reputation and relevance to the society (Hawkins *et al.*, 1973). All the SBs were published in highly renowned journals from business/management (*Journal of Management Studies; Organization Studies, Harvard Business Review*) and economics (*Rand Journal of Economics*). To relativize the importance of journals we ranked journals by impact factor (*cf.*, WoS). Belonging to the category of Management, our identified SBs are published in journals that are the 14th (*Journal of Management Studies*), 30th (*Organization Studies*) and 50th (*Harvard Business Review*) out of 173, and belonging to the category of Economics, the journal where the SB belongs to, is positioned at the 98th (*Rand Journal of Economics*) out of a total of 333.

Some similarities between the SBs are worth mentioning. There are three of them (Kaplan and Norton, 1992; Normann and Ramírez, 1993; Moore, 1993) that were published in the *Harvard Business Review*, all related with business strategy, but all focusing in different themes, such as performance measurement and the development of the balanced scorecard (Kaplan and Norton, 1992), strategy as the responsible for value creation (Normann and Ramírez, 1993), and competition (Moore, 1993). This variety of themes justifies the inexistence of significant co-citations between them. However, we can say that in those years (1992 and 1993), these themes were sleeping, but they have become emerging topics that have spurt the interest of academics and practitioners.

In terms of awakening periods, there are two SBs that awoke at the year of 1999. One related to patents counts (Trajtenberg, 1990) and the other related to performance measurement (Kaplan and Norton, 1992).

Trajtenberg (1990) studied the problems in using patent data in economic research seeking to find solutions to the problem of the existence of an enormous variance in the value of patents. He proposed solutions applied to a particular case (Computed Tomography Scanners) and found that citation-based patent indices are a way of measure social value of innovations. In short, he found that there was a high correlation between patents weighted by citations and the value of innovations, which led important innovations to become applied into innovative activities.

Kaplan and Norton (1992) have developed, after a year-long research project with 12 companies (leaders of performance measurement), a new way to measure company's performance, in order to improve and create value to their business. This new model of performance measurement was called Balanced Scorecard and it gives managers a faster and more comprehensive view of the business, simply by setting specific goals and measures based in their company's strategy and mission statements.

The SB Normann and Ramírez (1993) awoke in 2004, although it contains some assistant princes appearing in the years of 1998 and 1999, supporting the belief that value, competition and a new logic for competing through service had become emerging themes in innovation studies at those years. The focus on value creation led Normann and Ramírez (1993) to create a new logic of value, where the strategy was to reconfigure roles and relationships between stakeholders, seeking to create value by combining different players. The authors, after analyzing IKEA, Danish pharmacies and French public-service concessionaires, stated that the key task of a company is to integrate their competences with their customers.

Gaining attention in 2006 we have discovered some curiosities between our identified SBs. Having into account that the occurrence of a SB is a rare phenomenon (Glanzel *et al.*, 2003) - note that we have started our analysis with 52459 and we got only 6 SBs – it is even more rare the fact that we have found two SBs (Damanpour *et al.*. 1989, and Damanpour, 1992) from the same author, covering the same topic (innovation in organizations) and both awakening at the same year (2006).

Table 1: Sleeping Beauties identified (ordered by decreasing number of citations)

Name	Author(s) (Year of publication)	Journal [IF2013][a]	Awakening year[b]	Deviation (K)	Total Citations	Graph[c]
The balanced scorecard – measures that drive performance	Kaplan, RS; Norton, D.P. (1992)	Harvard Business Review [1.831], 50th/173	1999	0.819	1585	
A penny for your quotes – patent citations and the value of innovation	Trajtenberg, M. (1990)	Rand Journal of Economics [1.219], 98th/333	1999	0.823	522	
From value chain to value constellation – designing interactive strategy	Normann, R; Ramírez, R. (1993)	Harvard Business Review [1.831], 50th/173	2004	0.811	356	
Organizational size and innovation	Damanpour, F. (1992)	Organization Studies [2.504], 30th/173	2006	0.808	194	
Predators and prey – a new ecology of competition	Moore, J.F. (1993)	Harvard Business Review [1.831] 50th/173	2006	0.840	146	
The relationship between types of innovation and organizational performance	Damanpour, F; Szabat, K.A.; Evan, W.M. (1989)	Journal of Management Studies [3.277] 14th/173	2006	0.836	106	

Notes: a - The impact factor considered was from the Journal Citation Report of 2013; *b* - Author's estimation; *c* - The blue line represents the average citation pattern of a regular paper (obtained through the average citation pattern of the 7317 papers selected).
Source: Author's.

Damanpour *et al.* (1989) analyzes the impact of administrative and technical innovations on organizational performance. Using data from 85 public libraries through the years of 1970 to 1982, the authors concluded that the adoption of administrative innovations led to the posterior adoption of technical innovations. The other paper/SB, Damanpour (1992), studied the relationships between organizational size and innovations. To do that, the author analyzed 36 correlations from 20 published studies and figured out some positive associations between these two. Sharing a common author and a common awakening year, we believe that both were awake for the same reason.

Also awaking in 2006 and focusing his attention in the business perspective, Moore (1993) departed from the analysis of real case studies (as the ecosystems of IBM and Apple, specifically in personal computers or Wal-Mart and K mart in discount retailing) and suggested that a company should be strategically viewed as part of a business ecosystem, where there exists a large variety of industries and where each company works together in new innovations, and cooperatively and competitively supports their business ideals.

Although the themes of all 6 SB are related (impact of innovations in organizations; ways of measuring innovation's value and company's performances), in terms of co-citations there are no visible connections between them (see Table 2).

Table 2: Citations and co-citations between SBs of Table 1 (by decreasing order of citations)

Article – by decreasing order of citations		1	2	3	4	5	6
Kaplan; Norton (1993)	**1**	1585	2	3	0	0	1
Trajtenberg(1992)	**2**	2	522	0	2	0	0
Normann and; Ramírez (1993)	**3**	3	0	356	0	6	0
Damanpour (1992)	**4**	0	2	0	194	0	9
Moore (1993)	**5**	0	0	6	0	146	0
Damanpour; Szabat; Evan (1989)	**6**	1	0	0	9	0	106

Source: Data from ISI Web of knowledge and authors' computations by using MS Access queries.

In the following sections, we will display our SB-PR analysis by SBs decreasing order of citations.

4.2. Identifying the prince(s) for each SB

Seeking to find the Prince (PR) or Princes (PRs) for each SB identified, we had to follow some steps. In this section we display all the stages of this process that were

replicated to every single SB. The next display uses Kaplan and Norton (1992), the SB with the highest citation count.

To begin the analysis of a SB we have to extract their citation pattern, in this case, by extracting the list of articles that cite Kaplan and Norton (1992) (see Table 3).

As a first step, the candidates to PR shown in the previous list were reduced by excluding as a potential PR all those papers being cited less than or equal to 10 times.

To keep reducing this list, we have to keep using the pattern of citations as a way of measurement. The next step was to repeat the download process but now for the articles citing the potential PR. In this way we would have the data needed to count the co-citations.

Table 3: Part of the list of articles citing Kaplan and Norton (1992), the SB

Paper	Times Cited	Potential PR
Brown and Mitchell (1992)	28	Yes
Griffith (1994)	16	Yes
Hiltrop and Despres (1994)	6	No
Powell (1994)	2	No
Nohria and Berkley (1994)	8	No
Griffith *et al.*(1994)	3	No
Hackman and Wageman (1995)	443	Yes
Noci (1996)	4	No
Longbottom and Zairi (1996)	4	No
Ghalayini and Noble (1996)	101	Yes
Peterson and Niels(1997)	0	No
Sarkis *et al.* (1997)	12	Yes
Burke (1997)	7	No
Ghalayini *et al.* (1997)	71	Yes
Levinthal and Warglien (1999)	98	Yes
Martinsons *et al.* (1999)	122	Yes

Source: Author's.

In the two lists of articles (one with articles citing Kaplan and Norton, 1992, and another with articles citing potential PRs, using in this example Martinsons *et al.,* 2007) we counted the items that are simultaneously in both lists, the co-citations (see Table 4).

Table 4: Part of the list of articles citing Kaplan and Norton (1992) and Martinsons *et al.* (1999)

Paper	Cites the SB	Cites the PR	Co-citation
Bhagwat and Sharma (2007)	Yes	Yes	1
Ren (2008)	Yes	No	0
Davison *et al*. (2007)	Yes	Yes	1

*Source***:** Author's.

It is conjectured in the literature that the PR is an article that cites the SB in the year that the SB begins to be awaken (van Raan, 2004). Van Raan (2004) has found an extreme case with the longest sleeping period of his investigation and in which the PR was the first paper that cited the SB after ten years of dormancy. Therefore, the analysis could be reduced to the year in which occurs the awakening of SB. However, as *a priori* we do not have solid information to guarantee that this conjecture is always confirmed, we need to study as potential PRs all articles citing the SB with some impact in the literature (more than10 citations since their publication to present).

With the two lists, the next phase was based in the count of the co-citations.

To identify the co-citations we firstly used Excel to build the data table, and after importing the Excel table to Access, we used an Access query.

In the Excel table we placed information regarding all articles to study (the 8 articles identified in Table 3 as potential PRs (marked with a *yes* in the column 'Potential PR') plus the SB) considering only 2 columns. In the first column we placed a code that identifies the article cited and in the second column were placed the name of the article that cites that article. We cut those papers with less than or with 10 co-citations.

Table 5: Potential PRs of Kaplan and Norton (1992)

Paper	Journal Impact Rank	Times cited	Co-citations	Potential PR
Brown and Mitchell (1992)	1.867	28	3	No
Griffith (1994)	1.642	16	6	No
Hackman and Wageman (1995)	2.394	443	10	No
Ghalayini and Noble (1996)	1.518	101	43	Yes
Sarkis *et al*. (1997)	2.081	12	0	No
Ghalayini *et al*.(1997)	2.081	71	38	Yes
Levinthal and Warglien (1999)	3.807	98	0	No
Martinsons *et al.* (2007)	2.036	122	50	Yes

*Source***:** Author's.

Having in consideration the potential PRs with the highest citations and with a number of co-citations valid to be considered a PR (more than 10 co-citations), the list of potential PRs of Kaplan and Norton (1992) was reduced to 3 articles (see Table 6).

Table 6: Reduced list of the Potential PRs of Kaplan and Norton (1992)

Paper	Source	Journal Impact Rank	Times Cited	Co-citations
Ghalayini and Noble (1996)	International Journal of Operations & Production Management	1.518	101	31
Ghalayini *et al*. (1997)	International Journal of Production Economics	**2.081**	71	28
Martinsons *et al*. (1999)	Decision Support Systems	2.036	**122**	**42**

*Source***:** Author's.

After all these iterations, the relationship between potential PRs is the next step to analyze. To better understand the relationship between all potential PRs and the SB, we developed a graph that includes the citation pattern of the SB; the average of citations during a certain time till its awakening; the potential PRs and their occurrence, as well as their co-citations with the SB and also, some important relations (co-citations) between them.

In Figure 2 it is possible to notice the behavior of the SB. The potential PRs have been marked in the figure, as well as the year in which they emerged, the co-citations they have with the SB (i.e., with Kaplan and Norton, 1992), and the most relevant co-citations that have between them.

By analyzing the pattern of co-citations between potential PRs we are able to know whether there is a reinforcement of visibility of the SB caused by a combination of different papers/Princes (PRs). Such reinforcement can be explained either by the influence of the SB on new fields of knowledge (the princes belong to distinct areas of study) or in the same field (the Princes belong to the same area of studies). If various potential PRs belong to the same area of study/knowledge, then, they will present co-citations, while if they belong to distinct area it is likely that no significant number of co-citations exist between the PRs.

In case the of Kaplan and Norton (1992), after a period of 4 years having a very small number of citations, this SB started to receive an average of 10 citations per year after being cited by Ghalayini and Noble (1996). Thus, statistically, it is this paper that awakes Kaplan and Norton (1992). However, this SB maintained a stationary state and

only start attracting significant attention after 1999, when it was cited by Martinsons *et al*. (1999) (see Figure 2).
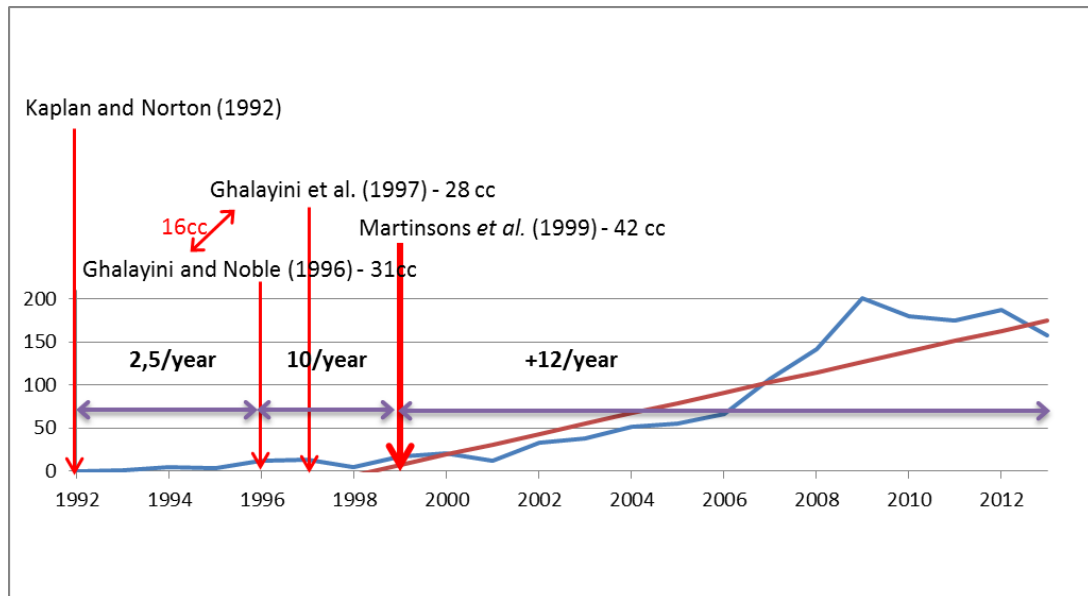

Figure 2: Citation pattern and potential PRs of Kaplan and Norton (1992)
Source: Author's.

By studying the papers candidates to being PRs of the SB Kaplan and Norton (1992), we found that the general theme that relates them all is "performance measurement". Kaplan and Norton (1992) introduce in the literature the concept of Balanced Scorecard, so it is natural that the SB has been cited by papers that address the topic of measuring performance. However, we think the explanation for the increase in the citations of this SB might be related to the existence of other publications that widely spread knowledge about the concept of balanced scorecard. These publications are from the same authors and portraying the same theme, but with improvements: a paper published in 1993 (Kaplan and Norton, 1993) and a book[4] published in 1996 (Kaplan and Norton, 1996). In 2000, a second book was launched (Kaplan and Norton, 2000), but in this year the SB was already wide awake, having an average of 12 citations per year.

Given the above, it seems clear that the PR of SB Kaplan and Norton (1992) is Martinsons *et al.* (1999), because it was published in the year that the SB awoke and it portrays the evolution of Balanced Scorecard, guided by papers of Kaplan and Norton and considering the book published in 2006 by these same authors.

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[4] Kaplan, R.S.; Norton, D. (1996), *The Balanced Scorecard: Translating Strategy into Action*, Harvard Business School Press.

Summing up, as Kaplan and Norton gained notoriety with the books they published, that notoriety led others authors to cite the SB as being the pillar of Balanced Scorecard. The improvements produced in the Balanced Scorecard further reinforced the SB's citation pattern, reaching 200 citations per year (see Figure 2).

4.3. Establishing the scientific relation between the prince and the sleeping beauty

Trajtenberg (1990)

Through an analysis of the SB Trajtenberg (1990), we found that the PR is Harhoff *et al*. (1999), awaking the SB 9 years after its publication.

The SB (Trajtenberg, 1990) and the respective potential PRs (Lerner 1994; Henderson *et al*., 1998; Harhoff *et al*., 1999; Jaffe *et al*., 1993; Harhoff *et al.,* 2003; Hall *et al*., 2005), share a common theme: patents and its derivatives (patent counts, patent citations, and patent rights. The year in which the SB started attracting more attention was in 1999, which coincided with a milestone in the history of the US patent law. In this year it was enacted a United States federal law named AIPA (American Inventors Protection Act). It regarded the rights of co-authors to license patent rights.

The authors of the potential PR from 1999 (Harhoff *et al.*, 1999) cite the SB again in 2003, (Harhoff *et al.*, 2003 - another possible PR) focusing on citations and their relation with the value of patent rights, thus matters related to the AIPA.

Other documents with changes in the law, also specifying in protecting inventors, like US Patent Law Amendments 1999 and United States – 1999 – 2000 Revisions of the Patent Law and Rules, also appeared in 1999.

It is important to notice that AIPA experienced amends in 2002, after the Intellectual Property and High Technology Technical Amendments Act of 2002 and the Public Law 107-273. Interestingly, all those potential PRs were reinforced, in terms of citations, after the year of 2003. Even though some of them have a good amount of citations and co-citations with the SB, the majority of those citations just emerge after the publication of Harhoff *et al*.'s (2003) study. For instance, over 87% of the citations of Jaffe *et al*. (1993) and over 93% of the co-citations between Jaffe *et al*. (2003) and the SB only appeared after 2003, as well as over 85% of the citations of Lerner (1994) and around 86% of its co-citations; 88% of the citations of Henderson *et al*. (1998) and also 88% of its co-citations with the SB; Harhoff *et al*. (1999) is the potential PR that presents the

highest number of co-citations denoting a pattern of a PR (see Table 7 and Figure 3). However, over 93% of its citations (and 95% of its co-citations) occurred after the publication of Harhoff *et al.* (2003).

Harhoff *et al.* (2003) is a thirteen year later improvement of Trajtenberg's (1990) contribution. Trajtenberg (1990) suggests that not only the number of citations a patent receives can determinate innovations' value, but the value of a patent is also positively related with the number of references to the patent literature.

Table 7: Potential PRs of Trajtenberg (1990)

Paper	Source	Journal Impact Rank	Times Cited	Co-citations
Jaffe *et al*. (1993)	Quarterly Journal of Economics	**5.966**	**1789**	109
Lerner (1994)	Rand Journal of Economics	1.219	205	57
Henderson *et al*. (1998)	Review of Economics and Statistics	2.718	351	43
Harhoff *et al*. (1999)	Review of Economics and Statistics	2.718	282	142
Harhoff *et al*. (2003)	Research Policy	2.598	215	81
Hall *et al*. (2005)	Rand Journal of Economics	1.219	457	**162**

*Source***:** Author's.

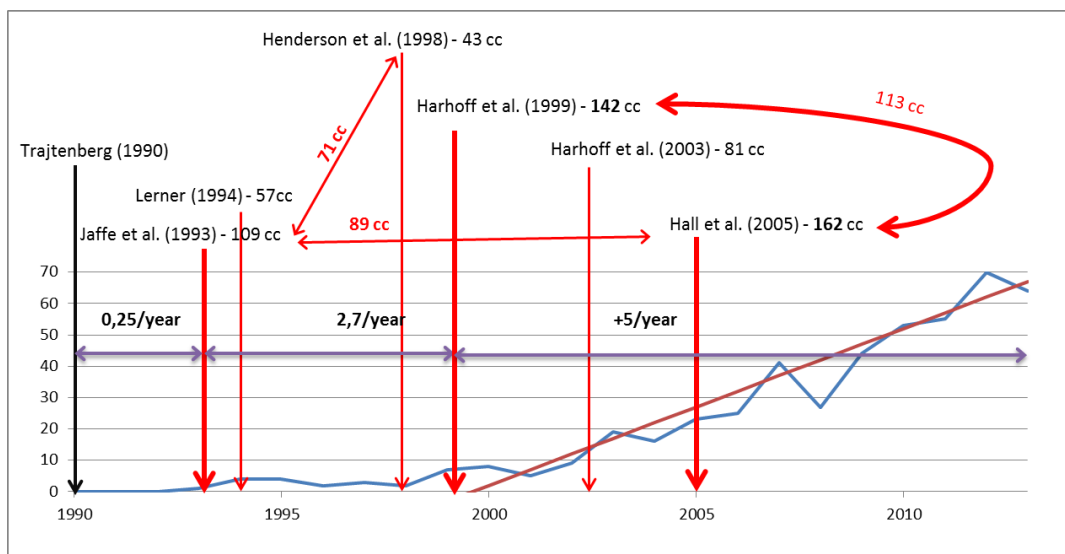**Figure 3:** Citation pattern and potential PRs of Trajtenberg (1990)
*Source***:** Author's.

Normann and Ramírez (1993)

Normann and Ramírez (1993) developed the topic of value as a marketing strategy. All of the potential PRs are papers about value, namely: "value for competitive advantage" (Stabell and Fjeldstad, 1998); "value co-production" (Ramírez, 1999); "co-creation of value" (Vargo and Lusch, 2004).

We found that the relationship between Normann and Ramírez (1993) and those articles which have more co-citations is much more complex than the cases presented in the literature. Thus, the awakening does not happen at once but it is intermittent: after the publication of each potential PR, the SB observes an increase in the number of citations. This pattern has never been described in literature: there is not a single PR responsible for the awakening of the SB, but the the result of a cumulative effect of multiple PRs.

The SB Normann and Ramírez (1993) awoke in 2004, although in 1998 and 1999 it faced the presence of what we might call "assistant PRs" (cf. Figure 4). The first 'assistant PR' is Stabell and Fjeldstad (1998) as it awoke the SB but afterwards this latter went to sleep again until 2003.

If we take into account the average citations per year, from 2004 on it starts to increase 5 points per year, so we can say that the SB was in dormancy for 11 years (1993-2004), awakening in the year of 2004, with the publication of the paper Vargo and Lusch (2004), the main responsible for the awakening of the SB. It is also the most cited article (1657 citations) and the one with more co-citations with the SB (102 cc). In this sense it is the PR, being Lusch *et al.* (2007) just a reinforcement in the citations pattern of the SB. Lusch *et al.* (2007) is a paper that exercises a strong influence in Vargo and Lusch (2004), having 136 co-citations between them. It focus on "competing through service", an emerging topic, that is intimately related to the theme of the SB and of the remaining potential PRs.

Vargo and Lusch (2004) is the paper that introduces the theme of the service-dominant logic (S-D logic) to the literature of marketing. S-D logic seeks to help marketers on how to compete through service, providing them a new framework for thinking clearly on the role of service in exchange and competition. Due to the fact that it is a new logic, it has been cited 1834 times in the ISI WoS (July 2nd, 2015) and 7031 times in the Google Scholar (July 2nd, 2015) and motivated later studies, journal issues and sections, and conferences in this field.

S-D Logic contains ten foundational premises, with eight of these existing since the initial Vargo and Lusch's (2004) article, the Prince of the SB Normann and Ramírez (1993). The other 2 premises were added in their Vargo and Lusch's 2008 article.

Analyzing Table 8 and Figure 4, we can conclude that Vargo and Lusch (2004) is the PR of Normann and Ramírez (1993), as it presents a high number of co-citations and a peak in citations of the SB after 2004.

Table 8: Reduced list of the Potential PRs of Norman and Ramírez (1993)

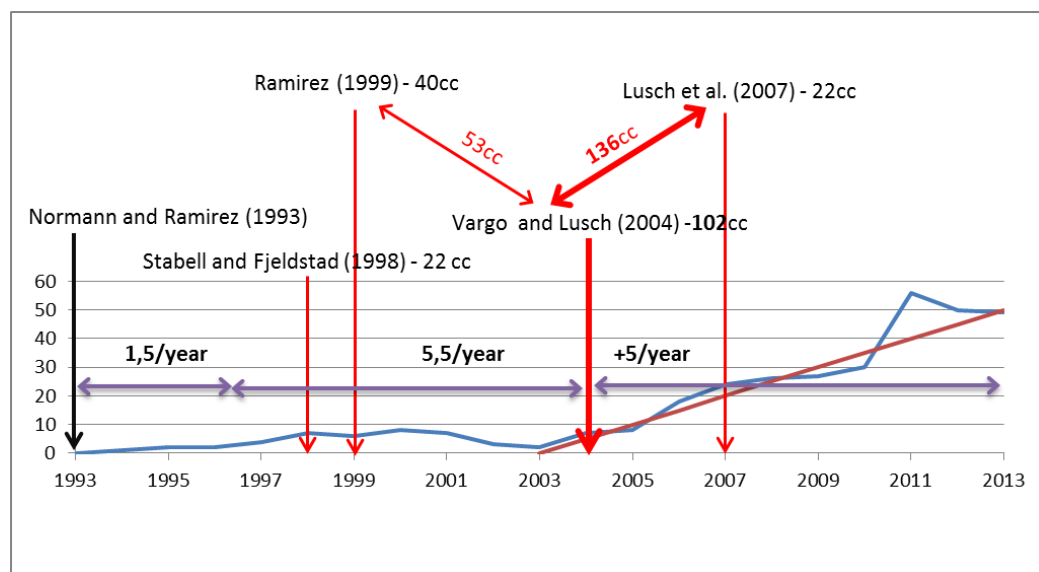| Paper	Source	Journal Impact Rank	Times Cited	Co-citations
Stabell and Fjeldstad (1998)	Strategic Management Journal	2.993	237	22
Ramírez (1999)	Strategic Management Journal	2.993	176	40
Vargo and Lusch (2004)	Journal of Marketing	**3.819**	**1657**	**102**
Lusch *et al*. (2007)	Journal of Retailing	1.193	228	22

Source: Author's.

Figure 4: Citation pattern and potential PRs of Normann and Ramírez (1993)
Source: Author's.

Damanpour (1992)

The SB's (Damanpour, 1992) and the potential PRs' (Damanpour, 1996; Camison-Zornoza *et al*., 2004; Damanpour and Schneider, 2006) main themes are "organizational size" and "organizational innovation"

After an analysis on the content and on the bibliometric data, we were able to identify a PR responsible for the awakening of this SB. However, it was difficult to identify only one PR, since the wakening phenomenon was associated with 5 distinct PRs.

It is interesting to notice that Damanpour is not just the author of this SB, but is also the author of two PR candidates. The deepening of the analysis initiated by Damanpour in 1992 proceeded with other authors, with the development and testing of multiple contingency models to understand the organizational complexity and innovation

(Damanpour, 1996) and investigating the phases of the adoption of innovation in organizations, having as scope the study of the effects of environment, organization and top managers when innovation is adopted (Damanpour and Schneider, 2006).

By analyzing the citation patterns of each of the 5 potential PRs over the years, we figured out that Damanpour and Schneider (2006) is the most likely PR of the SB. Indeed, all the co-citations of every potential PR published before 2006 occurred after 2006, which supports the content that all of them were being reinforced in terms of citations after the publication of Damanpour and Schneider (2006). Although Camison-Zornoza *et al.*'s publication occurs near the awakening of the SB, the latter's bulk of citations (97%) and co-citations (93%) happens after 2006.

Table 9: Potential PRs of Damanpour (1992)

| Paper	Source	Journal Impact Rank	Times Cited	Co-citations
Damanpour (1996)	Management Science	**2.524**	221	24
Chwelos *et al.* (2001)	Information Systems Research	2.322	**265**	8
Zhu *et al.* (2003)	European Journal of Information Systems	1.654	151	13
Camison-Zornoza *et al.* (2004)	Organization Studies	2.504	95	**28**
Damanpour and Schneider (2006)	British Journal of Management	1.909	135	12

Source: Author's.
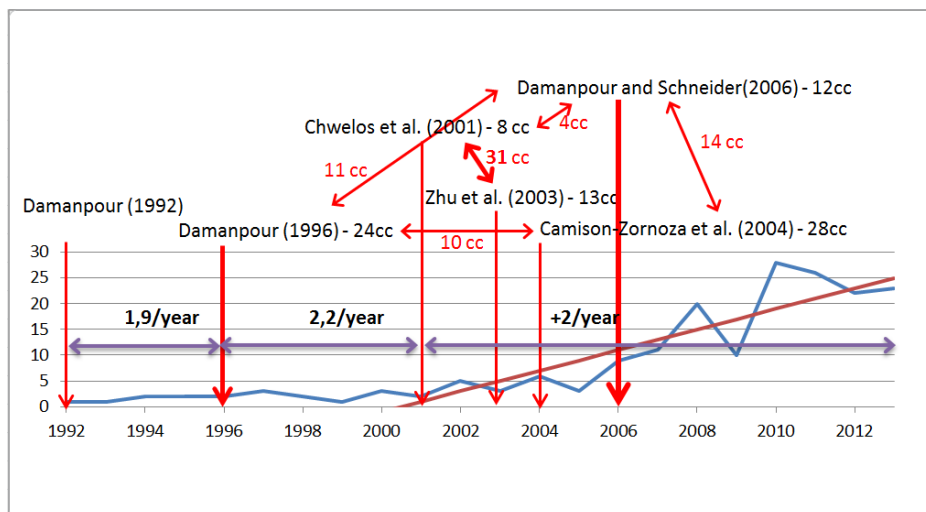
Figure 5: Citation pattern and potential PRs of Damanpour (1992)
Source: Author's.

Moore (1993)

For the SB Moore (1993), we failed to clearly point the paper responsible for its awakening, that is, its prince.

The SB analyzes real case studies (the ecosystems of IBM and Apple, specifically in personal computers or Wal-Mart and K mart in discount retailing) and we noticed that the potential PRs generally depict analysis of strategies adopted by different firms, also based on case studies such as "Cisco Systems" (Kraemer and Dedrick, 2002; Li, 2009), "telecommunications operators" (Rohrbeck et al., 2009; Basole, 2009), and the "Deutsch Telekom" (Rohrbeck *et al.,* 2009). Moreover, the generality of the potential princes focused the themes of "organizational strategy" (Farjoun, 2002; Kraemer and Dedrick, 2002; Rohrbeck *et al.,* 2009; Basole, 2009; Li, 2009) and "business ecosystems" (Rohrbeck *et al.,* 2009; Basole, 2009; Li, 2009).

The SB was sleeping until 2001, was awake in 2002, but fell asleep again in 2003 (see Figure 6). It is only in 2006 that we can state that the SB got enough attention and its citations started to grow. Considering this latter awakening, the sleeping period of Moore (1993) was 13 years.

In this particular case, the potential princes have less than 10 co-citations, and thus not effective prince can be highlighted (See Table 10 and Figure 6).

Table 10: Potential PRs of Moore (1993)

| Paper	Source	Journal Impact Rank	Times Cited	Co-citations
Dodd (2002)	Journal of Business Venturing	3.265	46	0
Farjoun (2002)	Strategic Management Journal	2.993	**69**	1
Kraemer and Dedrick (2002)	Journal of Strategic Information Systems	2.571	43	1
Rohrbeck *et al*. (2009)	R&D Management	1.266	23	1
Basole (2009)	Journal of Information Technology	**3.789**	24	5
Li (2009)	Technovation	2.704	22	**8**

*Source***:** Author's.
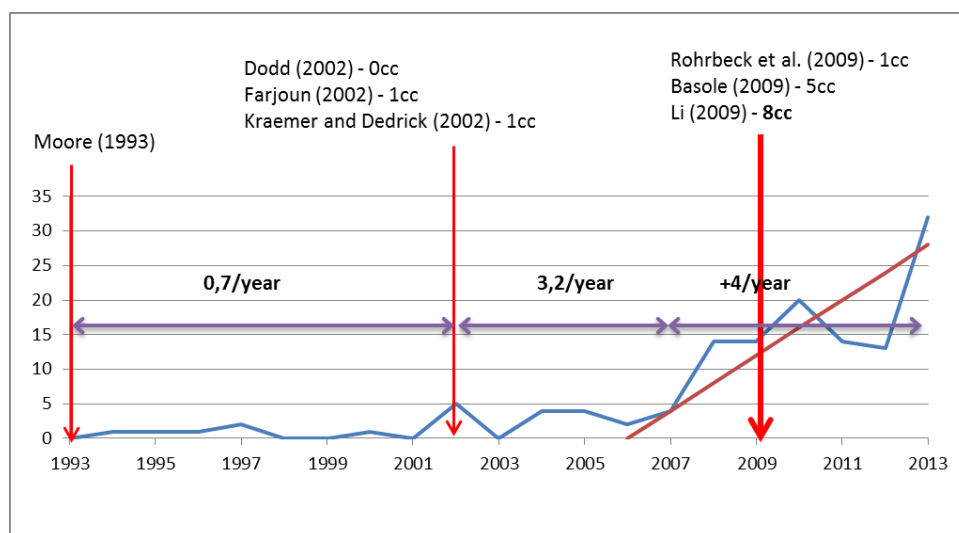
Figure 6: Citation pattern and potential PRs of Moore (1993)
*Source***:** Author's.

Damanpour *et al.* (1989)

The core themes of this SB and its potential PRs include "organizational performance" (Damanpour *et al.*, 1989; Walker and Boyne, 2006), "organizational innovativeness" (Subramanian and Nilakanta, 1996; Armbruster *et al.,* 2008), and "innovation types in organizations" (Damanpour *et al.*, 1989; Walker, 2006; 2008).

From the time when the SB awakes (2006) all candidates to be PR are studies conducted in Europe, focusing government and local policy management (Walker and Boyne, 2006; Walker, 2006; 2008) and German manufacturing companies (Armbruster *et al.*, 2008). All these potential princes draw on innovation data whose standards were established by the Oslo Manual ("Guidelines for Collecting and Interpreting Innovation Data", a joint publication of OECD and Eurostat). The publication of the 2005 Oslo Manual influenced, at least in part and indirectly, the awakening of this SB.By analyzing the citation patterns of the 5 potential PRs, we believe that any potential PR published in 2006 (Walker and Boyne, 2006; Walker, 2006) is the most likely to be the PR of the SB. (See Table 11 and Figure 7)

Table 11: Potential PRs of Damanpour et al. (1989)

| Paper	Source	Journal Impact Rank	Times Cited	Co-citations
Subramanian and Nilakanta (1996)	Omega-International Journal of Management Science	3.190	132	18
Han *et al*. (1998)	Journal of Marketing	**3.819**	**583**	**31**
Walker and Boyne (2006)	Journal of Policy Analysis and Management	2.262	55	2
Walker (2006)	Public Administration	1.863	43	4
Walker (2008)	Journal of Public Administration Research and Theory	2.875	50	4
Armbruster *et al*. (2008)	Technovation	2.704	57	10

*Source***:** Author's.
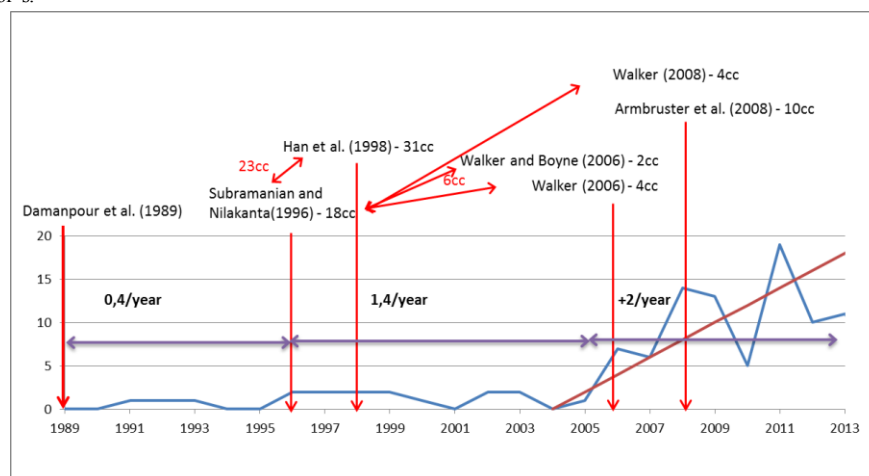
Figure 7: Citation pattern and potential PRs of Damanpour et al. (1989)
Source: Author's.

5. Conclusion

Seeking to find Sleeping Beauties in Innovation and to understand the reasons behind their occurrence, we took a quantitative/bibliometric methodology, adapting and modifying the method of van Raan's (2004). This approach allowed us to identify quickly and accurately the potential SBs in innovation field. The method was applied to 52459 papers extracted from the Web of Science bibliographic database with 'innovation' as keyword (filtered by 'social science' and 'business economics'), from 1900 to 2015. By excluding those papers with 20 citations or over, the list was reduced to 7317 papers and 6 Sleeping Beauties in the Innovation field were discovered.

From the 6 SBs, 4 were in dormancy for more than 10 years, which shows that some themes in innovation have been only lately attracting the curiosity of academics. We found cases in agreement with the literature, that is, papers awakening because of: the notoriety of the authors (Kaplan and Norton, 1992); the publication of books (Kaplan and Norton, 1992) or other papers (Normann and Ramírez, 1993); the publication of manuals with standards (Damanpour *et al.*, 1989); and amendments of the law (Trajtenberg, 1990).

Some of the SBs proved to be publications ahead of their time. The Balanced Scorecard (Kaplan and Norton, 1992) is one of those cases - a theme that gained attention after 9 years when their authors started gaining notoriety. Changes in institutional frameworks and standards (e.g. the publication of amendments on the patent law of the United States, as in the case of M. Trajtenberg, 1990, "A penny for your quotes: Patent citations and the value of innovations", *Rand Journal of Economics*) or the influence of key related policy making institutions such as the OCED and Eurostat (e.g., the publication of Oslo Manual by OECD/Eurostat in the case of F. Damanpour, K.A. Szabat, W.M. Evan, 1989, "The relationship between types of innovation and organizational performance", *Journal of Management Studies*) proved to be determinant of the paper's citation path.

The discovery of SBs in this field, as well as the analysis of the reasons for their emergence/awakening gives us an overview of the evolution of the literature in the innovation field. Our methodology gives us exact results. However, our conclusions are not exact science, but the building of argumentation based on literature research.

Further work is necessary to understand some particular cases, namely to figure out over year what institutional changes in the field of innovation might have caused some SBs awakening.

References

Armbruster, H.; Bikfalvi, A.; Kinkel, S.; Lay, G. (2008), "Organizational innovation: The challenge of measuring non-technical in large-scale survey", *Technovation*, 28 (10): 644-657.

Basole, R.C. (2009), "Visualization of interfirm relations in a converging mobile ecosystem", *Journal of Information Technology*, 24 (2): 144-159.

Burrell, Q.L. (2005), "Are 'sleeping beauties' to be expected", *Scientometrics*, 65 (3): 381–389.

Butcher, J.; Jeffrey, P. (2005), "The use of bibliometric indicators to explore industry-academia collaboration trends over time in the field of membrane use for water treatment", *Technovation*, 25: 1273-1280.

Camison-Zornoza, C.; Lapiedra-Alcami, R.; Segarra-Cipres, M.; Boronat- Navarro, M. (2004), "A meta-analysis of innovation and organizational size", *Organization Studies*, 25 (3): 331-361.

Choi, D.G.; Lee, H.; Sung, T. (2011), "Research profiling for 'standardization and innovation", *Scientometrics*, 88: 259-278.

Chwelos, P.; Benbasat, I.; Dexter, A. (2001), "Research report: empirical test of an EDI adoption model", *Information Systems Research*, 12 (3): 304-321.

Damanpour, F. (1992), "Organizational size and innovation", *Organization Studies*, 13 (3): 375–402.

Damanpour, F. (1996), "Organizational complexity and innovation: developing and testing. Multiple contingency models", *International Journal of Management Science*, 42(5): 693-716.

Damanpour, F.; M. Schneider (2006), "Phases of the adoption of innovation inorganizations: effects of environment, organization, and top managers", *British Journal of Management*, 17 (3): 215-236.

Damanpour, F.; Szabat, K.A.; Evan, W.M. (1989), "The relationship between types of innovation and organizational performance", *Journal of Management Studies*, 26 (6): 587-602.

Dodd, S.D. (2002), "Metaphors and meaning. A grounded cultural model of US entrepreneurship", *Journal of Business Venturing*, 17, 519–35.

Garfield, E. (1980), "Premature discovery or delayed recognition - Why?", *Current Contents*, 4: 888-493.

Ghalayini, A.M.; Noble, J.S. (1996), "The changing basis of performance measurement", *International Journal of Operations and Production Management*, 16 (8): 63-80.

Ghalayini, A.M.; Noble, J.S.; Crowe, T.J. (1996), "An integrated dynamic performance measurement system for improving manufacturing competitiveness*", International Journal of Production Economics*, 48 (3): 207-225.

Glänzel, W.; Schubert, A. (2003), "A new classification scheme of science fields and subfields designed for scientometric evaluation purposes". *Scientometrics*, 56 (3): 357-367.

Hall, B.H.; Jaffe, A.; Trajtenberg, M. (2005), "Market value and patent citations", *Rand Journal of Economics*, 36 (1): 16-38.

Harhoff, D.; Narin, F.; Scherer, M.; Vopel, K. (1999), "Citation frequency and the value of patented inventions", *The Review of Economics and Statistics*, 81 (3): 511-515.

Harhoff, D.; Scherer, F.M.; Vopel, K. (2003), "Citations, family size, opposition and the value of patent rights", *Research Policy*, 32 (8): 1343-1363.

Hauser, J.; Tellis, G.J.; Griffin, A. (2006), "Research on innovation: a review and agenda for marketing science", *Marketing Science*, 25 (6): 687-717.

Hawkins, R.G.; Ritter, L.S.; Walter, I. (1973), "What economists think of their journals", *Journal of Political Economy*, 81: 1017–32.

Henderson, R.; Jaffe, A.B.; Trajtenberg, M. (1998), "Universities as a source of commercial technology: a detailed analysis of university patenting, 1965-1988", *Review of Economics and Statistics*, 80: 119-127.

Holsapple, C.W.; O'Leary, D.E. (2009), "How much and where? Private vs. public universities' publication patterns in the information systems discipline", *Journal of the American Society for Information Science and Technology*, 60 (1): 318-331.

Hu, Z.; Wu, Y. (2014), "Regularity in the time-dependent distribution of the percentage of never-cited papers: An empirical pilot study based on the six journals", *Journal of Informetrics*, 8 (1): 136-146.

Jaffe, A.B.; Trajtenberg. M.; Henderson, R. (1993), "Geographic localization of knowledge spillovers as evidenced by patent citations", *Quarterly Journal of Economics*, 108 (3): 577-598.

Kalaitzidakis, P.; Mamuneas, T. P.; Stengos, T. (2001), "Rankings of academic journals and institutions in economics", *Discussion Papers of the University of Cyprus*, 10: 1–29.

Kaplan, R.S.; Norton, D. (1992), "The balanced scorecard: measures that drive performance", *Harvard Business Review*, 70 (1): 71–79.

Ke, Q.; Ferrara, E.; Radicchi, F.; Flammini, A (2015), "Defining and identifying sleeping beauties in science", *PNAS*, 112 (24): 7426-7431.

Kozak, M. (2013), "Current science has its 'sleeping beauties'", *Current Science*, 104 (9): 1129-1130.

Kraemer, K.L.*;* Dedrick, J. (2002), "Strategic use of the internet and e-commerce: Cisco Systems", *Journal of Strategic Information Systems,* 11(1): 5-29.

Lazzarotti, F.; Dalfovo M.S.; Hoffmann, V.E. (2011), "A bibliometric study of innovation based on Schumpeter", *Journal of Technology Management and Innovation*, 6: 121-135.

Lerner, J. (1994), "The importance of patent scope: an empirical analysis", *Rand Journal of Economics*, 25 (1): 319-333.

Leydesdorff, L.; Rotolo, D.; de Nooy, N. (2013), "Innovation as a nonlinear process, the scientometric perspective, and the specification of an 'innovation opportunities explorer' ", *Technology Analysis and Strategic Management.* 25 (6): 641-653.

Li, J. (2014), "Citation curves of "all-elements-sleeping-beauties": "flash in the pan" first and then "delayed recognition" ", *Scientometrics,* 100 (2): 595-601.

Li, J.; Ye, F.Y. (2012), "The phenomenon of all-elements-sleeping-beauties in scientific literature", *Scientometrics,* 92 (3): 795–799.

Li, Y. (2009), "The technological roadmap of Cisco's business ecosystem". *Technovation*, 29 (5): 379-386.

Li., J.; Shi, D.; Zhao, S.X.; Ye, F.Y. (2014), "A study of the "heartbeat spectra" for "sleeping beauties" ", *Journal of Informetrics,* 8 (3): 493-502.

Lusch, R.F.; Vargo, S. L.; O'Brien, M. (2007), "Competing through service: Insights from service-dominant logic", *Journal of Retailing*, 83 (1): 5-18.

Ma, Z.; Pan, Y., Yu, Z.; Wang, J.; Jia, J.; Wu, Y. (2013), "A quantitative study on the effectiveness of peer review for academic journals", *Scientometrics,* 95 (1): 1-13.

Martinsons, M.; Davison, R.; Tse, D., (1999), "The balanced scorecard: a foundation for the strategic management of information systems", *Decision Support Systems*, 25 (1): 71-88.

Moore, J.F. (1993), "Predators and Prey: A New Ecology of Competition", *Harvard Business Review*, 71 (3): 75–86.

Normann, R.; Ramírez, R. (1993). "From value chain to value constellation: Designing interactive strategy", *Harvard Business Review*, 71 (4): 65-77.

Ohba, N.; Nakao, K. (2012), "Sleeping beauties in ophthalmology", *Scientometrics*, 93 (2): 253–264.

Polt, W.; Rammer, C.; Schartinger, D.; Gassler, H.; Schibany, A. (2011), "Benchmarking industry-science relations in Europe – the role of framework conditions", *Science and Public Policy*, 28 (4): 247-258.

Qin, J. (1994), "An investigation of research collaboration in the sciences through the philosophical transactions 1901-1991", *Scientometrics*, 29 (2): 219-238.

Qin, J.; Lancaster, F.W.; Allen, B. (1997), "Types and levels of collaboration in interdisciplinary research in sciences", *Journal of the American Society for Information Science*, 48 (10): 893-916.

Ramírez, R. (1999), "Value co-production: Intellectual origins and implications for practice and research", *Strategic Management Journal*, 20: 49–65.

Rohrbeck, R.; Hoelzle, K.; Gemuenden, H. G. (2009), "Opening up for competitive advantage–how Deutsche Telekom creates an open innovation ecosystem", *R&D Management*, 39 (4): 420-430.

Schmoch, U.; Laville, F.; Patel, P.; Frietsch, R. (2003), *Linking Technology Areas to Industrial Sector*s. Final Report to the European Commission, *DG Research*, Karlsruhe: Fraunhofer ISI.

Stabell, C.B.; Fjeldstad, Ø.D. (1998), "Configuring value for competitive advantage: on chains, shops, and networks", *Strategic Management Journal*, 19 (5): 413–437.

Subramanian, A.; Nilakanta, S. (1996), "Organizational innovativeness: exploring the relationship between organizational determinant of innovation, types of

innovations and measures of organizational performance", *International Journal of Management Science*, 24 (6): 631-47.

Trajtenberg, M. (1990), "A penny for your quotes: Patent citations and the value of innovations", *Rand Journal of Economics*, 21: 172-187.

van Raan, A.F.J. (2004), "Sleeping beauties in science", *Scientometrics*, 59 (3): 467–472.

Vargo, S.L.; Lusch, R.F. (2004), "Evolving to a new dominant logic for marketing", *Journal of Marketing*, 68 (1): 1-17.

Volberda, H.W.; Van Den Bosch, F.A.J.; Heij, C.V. (2013), "Management innovation: management as fertile ground for innovation", *European Management Review*, 10 (1): 1–15.

Walker, R.M. (2008), "An empirical evaluation of innovation types and organizational and environmental characteristics: towards a configuration framework", *Journal of Public Administration Research and Theory*, 18 (4): 591-615.

Walker, R.M.; Boyne, G.A. (2006), "Public management reform and organizational performance: an empirical assessment of the UK Labour government's public service improvement strategy", *Journal of Policy Analysis and Management*, 25: 371-394.

Walker, R.M. (2006), "Innovation type and diffusion: an empirical analysis of local government", *Public Administration*, 84 (2): 311-335.

Wang, J.; Ma, F.; Chen, M.; Rao, Y. (2012), "Why and how can sleeping beauties be awakened?", *The Electronic Library*, 30 (1): 5–18.

Table A1: What has been researched and concluded in the literature of sleeping beauties (field, methodology, findings and gaps)?

Title	Author	Type	Field	Methodology	Findings	Gaps
Citation curves of ""all-elements-sleeping-beauties"": ""flash in the pan"" first and then ""delayed recognition""	Li J.	Quantitative analysis	Scientometrics	In this work, both of the princes were determined by professional scholars in Physics rather than quantitative techniques. -we briefly discussed the citation curves of two remarkable 'all-elements-sleeping-beauties''. Three variables are considered in SB: (1) depth of sleep (cs)); (2) length of sleep(s)(3) awakening intensity (cw). These modalities encouraged quantitative analysis of delayed recognition (Burrell 2005; van Dalen and Henkens 2005; Braun et al. 2010; Ohba and Nakao 2012), but were defined in an arbitrary manner (van Clester 2012). -we present **two remarkable examples** to demonstrate that the citation curve of an ''all-elements sleeping- beauty'' appears ''flash in the pan'' first and then ''delayed recognition''.	The citation curve of an ''all-elements sleeping - beauty'' appears ''flash in the pan'' first and then ''delayed recognition'. (Also find a happy ending as in the fairy tale') The leaping before sleeping is usually overdrawn in the sleeping period. Prince received 1244 citations, which was much more than the 258 citations of the sleeping beauty. This was termed ''male dominance'' in the couple by Braun et al. (2010).	The two examples initiate two questions to be addressed in further studies. One question is that the leaping before sleeping is usually overdrawn in the sleeping period, if the ''sleeping beauties'' is only defined by the number of total or average citations, regardless of the citation distribution. -More difficult to identify the prince of a sleeping beauty than herself, if we have no professional background in the field.
A study of the ""heartbeat spectra"" for ""sleeping beauties""	Li J., Shi D., Zhao S.X., Ye F.Y.			Investigated 58963 papers of Nobel laureates during 1900–2000 and found 758 sleeping beauties. By proposing and using Gsindex, an adjustment of Gini coefficient, to measure the inequality of "heartbeatspectrum". -The criteria that Garfield (1989) set are as follows: (1) highly cited papers that had low citation frequencies for the first 5 or more years, with more than 10 years being preferred, and (2) low initial citation frequency was defined as being near the average of one cite per year for atypical paper.	Publications which possess "late heartbeats" (most citations were received in the second half of sleeping period) have higher awakening probability than those have "early heartbeats" (most citations were received in the first half of sleeping period). The awakening probability appears the highest if an article's Gsindex exists in the interval [0.2, 0.6]. Found **758 sleeping beauties**	
Regularity in the time-dependent distribution of the percentage of never-cited papers: An empirical pilot study based on the six journals	Hu Z., Wu Y.		Scientometrics -empirical study /empirical pilot analysis	After reviewing all the related papers in Web of Science, Google Scholar and Scopus database, we find the current literature on citation distribution gives more focus on the distribution of the percentages and citations of papers receiving at least one citation, while there are fewer studies on the time-dependent patterns of the percentage of never-cited paper. Here, we perform an empirical pilot analysis to the time-dependent distribution of the percentages of never-cited papers in a series of different, consecutive citation time windows following their publication in our selected **six sample journals**, and study the influence of paper length on the chance of papers' getting cited. We select the **four journals** from the twelve source journals in **Information Science** Minimum of **600 papers published during 1992–1999 period** and the top IFs in respective domain are the two criteria for our selection of sample journals so they function as good references relative to the four journals in one discipline – Information Science		There are **very few scholars who pay attention to the relationship between the length of papers and uncitedness.**

Title	Author	Type	Field	Methodology	Findings	Gaps
Current science has its 'sleeping beauties'	Kozak M.	Quantitative analysis	Current Science	According to Ohba and Nakao, a **paper should be cited at least 100 times** <u>sometime after its initial publication</u> **to be considered a Sleeping Beauty.** -papers that have around **100 or more citations** -citation analyses were carried out in **WoS by Thompson Reuters**	Finding a Prince is not so easy	Finding a Prince is not so easy -difficult to decide which paper(s) constituted the Prince(s). It is possible that something else constitutes the Prince, for example a conference presentation in which the Sleeping Beauty is rediscovered, but this would be very difficult to detect.
A quantitative study on the effectiveness of peer review for academic journals	Ma Z., Pan Y., Yu Z., Wang J., Jia J., Wu Y.	Quantitative study and quality analysis	Scientometrics	Effectiveness of Peer Review (EPR), is defined for evaluating the effectiveness of peer reviewing. Sample experiment, **28 academic journals were tested,** and the EPR indicator was able to reflect accurately the academic impact of those journals. In this study, **set S** is defined as the total submissions in 1 year, it comprises **four Subset**s—A, B, C, and D, where Set A consists of all the papers that should be rejected and are rejected; B - papers that should be accepted but are rejected; C - papers that should be accepted and are accepted; D -papers that should be rejected but are accepted. According to these definitions, set S is the union of A, B, C, and D, and the intersection set between any two subsets is a null set: **S=A U B U C U D** In the present study, the essential thinking is that papers without citations are unqualified ones. At the same time, a parameter, m, which is similar but different to b in our prior research (Zheng Ma 2012), is designed to correct the erratum of n(C) in regard to those sleeping papers. As a test sample, **we calculated the EPR for 2008–2010 for 28 primary journals** associated With the American Psychological Association (2009, 2010, 2011), which issues annually detailed statistics with regard to acceptance and rejection by American Psychologist. All the citations were obtained from the statistics of the ISI-Web of Science up to February 2012.	Theoretically, peer reviews should be able to evaluate all manuscripts accurately, which would mean that **sets B and D would be null** sets; thus, in an ideal situation, the circle with the dashed line and that with the solid line should coincide. In other words, **all the quality papers are accepted, and all the substandard papers are rejected.** The **maximum value of EPR is 5.2** and the **minimum value is 1.2.** Therefore, we can see that EPR has the ability to distinguish the peer-reviewing effectiveness of the sample journals. -journals have a lower impact factor and lower EPR, which indicates that a lack of effectiveness in the peer reviewing possibly results in the lack of impact of these journals. -journals achieve a higher impact factor and good EPR. It is clear that the best journals must operate an effective peer-review mechanism….tendency that **the higher the ERP for a journal**, **the higher is its impact factor**. "Although it is a popular viewpoint that an increasing rejection rate is a sign of a successful journal (Warner 2007), from the present study an increasing EPR should be the real mark of a quality journal that is able to achieve sustainable success"	Although researchers have come to realize that more studies are needed to define whether peer review plays its proper role (Fletcher 1997), the larger question of whether peer review actually works has thus far not been directly examined (Veitch 2001). "Aarssen (2008) suggested that journals should report their submission and rejection statistics annually to reflect the real quality of papers published. However, since most journals maintain silence on this subject, such data are hard to obtain. Even for the available data reported by journals, it is difficult to be certain of their accuracy. Not providing such data is clearly in the interests of the journal's publisher; however, since almost all publishers possess such data, they could conduct self-evaluation in the manner outlined in the present study."
Sleeping beauties in ophthalmology	Ohba N., Nakao K.	Quantitative analysis	Ophtalmology	We screened citation histories of 184606 articles in 52 ophthalmology journals using the <u>Science Citation Index-Expanded</u> (Thomson Reuters). *Nine articles were identified as SBs.* Awake intensity considered was = first 5 years period following awakening; -100 or more citations; -up to 2010 - searched for 'Prince' article (PR) that was published around the time of SB awakening and must have prompted the authors of subsequent related works to refer to the SB. The strength of co-citations was determined by the frequency with which the <u>SB–PR pair</u> is <u>cited together in the reference.</u> -The 11 PRs were published in ophthalmology journals that are top-ranked in the journal impact factor	**Self-citations**, an essential part of scientific communication (Braun et al. 2010), proved to **play a role of PR in three of the current SBs.** Time needed to confirm and extend experience of new diseases and technologies is likely relevant to the delay in citation recognition of clinical study. It is notable in the current literature search of 52 ophthalmology journals that the SBs and PRs appeared in a few ophthalmology journals that are top-ranked in the journal impact factor and publish high quality articles (Cartwright and McGhee 2005; Ohba 2007; Sims and McGhee 2003).	There are limitations in the current results of delayed recognition articles in the ophthalmology. We may have overlooked articles concerning ophthalmology that fulfilled the criteria for delayed recognition but were published in non-ophthalmology journals. Although the database Science Citation Index-Expanded claim citation data as far back as 1900, it may underestimate citation histories before 1960.

Title	Author	Type	Field	Methodology	Findings	Gaps
The phenomenon of all-elements-sleeping-beauties in scientific literature	Li J., Ye F.Y.			We find **four special cases**, in which sleeping beauties seem to be injured by spindles so that they fall into sleep then are awakened by princes. The four 'sleeping beauties' were **different from normal ones, because they had a leaping before sleeping.** As publications that have changed science and the world, the **four cases are persuasively of high-quality.** They have received the least total citations, ranged from 100 to 172, among the 21 discoveries listed in Garwin and Lincoln's book. Nevertheless, **three of the findings lead to Nobel prizes.**	The common ground the princess's share is the three stages of their citation history: 1st, they were active in the first 2 years since they were published, and the annual citations they received roared up, higher than their average citations per year. 2nd, the spindles appeared and they were injured to sleep afterwards. 3rd, the prince's kiss awakened them and their annual citations increased significantly. We hence **speculate that the phenomenon of all-elements-sleeping-beauty happens in significant important scientific literatures.** Peyton Rous was awarded the 1966 Nobel prize in medicine for his work on cancer virus that bears his name Rous sarcoma, which was discovered in 1911. Only after a leukemia virus was isolated in 1951 could Rous' discovery be appreciated (Garfield 1980). The **rediscovery** of Rous sarcoma virus started the virus-theory trend in cancer research.	There is no perfect methodology for judging articles' quality, our finding suggests a potential way to reach a judgment.
Why and how can sleeping beauties be awakened?	Wang J., Ma F., Chen M., Rao Y.	Qualitative study		Time, information value, access and demand of information are the variables that the authors believe justify the occurrence of SBs.	Based on the three basic elements of information utilisation- **information value**, **access channel** and **user needs**. Information value is re-mined because of the relevance among various information; different uses of information are discovered; information availability and visibility are improved; information is placed into the appropriate place; and, with time passing by, demands for the information rise.	
Are ""sleeping beauties"" to be expected?	Burrell Q.L.	Quantitative analysis	Informetrics/scientometrics	**Stochastic model:** The essence of the model is to suppose that any paper receives citations after its publication in a **random** fashion over time but that different papers differ in the rates at which they receive citations, perhaps reflecting their perceived importance. -We imagine a collection of papers published at time zero and denote by X(s) the number of times a typical paper has been cited by time s, i.e. the end of year s, or during the first s years following publication. Note that we are modelling a discrete time process and we set $X(0) = 0$. Also write $Y(s, m) = X(s+m) - X(s) =$ **number of times the paper is cited in the m years after time s.** -...for a SB we are interested in papers for which X(s) is 'small', so the paper has been little cited by time s, but that Y(s,m) is 'large', so that the paper is much cited in the following m years. -To give a **quantitative aspect** to the definition of Sleeping Beauties, VAN RAAN(2004) notes three essential variables: length, depth of sleep, awake intensity. "Again, following van Raan we consider only the case of $m = 4$"	With four parameter values to be chosen and rather complicated expressions to be evaluated, we were unable to identify an optimal procedure and instead adopted a trial and error approach. We would argue that informetrics/scientometrics is not just a matter of mathematical/statistical modelling (or analysis) but should always be directly addressed at a particular problem by taking full account of its context.	Unfortunately there is **insufficient information in VAN RAAN** (2004) to allow us to make proper estimates of these parameters. "we have **failed to demonstrate that "outrageous" Sleeping Beauties those lying dormant for a long period but then bursting into hyperactive life! – might be expected**"

Title	Author	Type	Field	Methodology	Findings	Gaps
Sleeping Beauties in science	Van Raan A.F.J.		Bibliometric approach	We derived from the measurements an '**awakening' probability function** and identified the 'most extreme Sleeping Beauty so far'. -3 main variables: depth of sleep, length, awake intensity Using our very large CWTS scientific publication data-system (SCI, SSCI, AHCI, ISI) with about 20,000,000 articles from 1980 up till now and a total volume of about 300,000,000 citations, we carried out the following measuring procedure. For **6 sleeping periods** with **length s = 5, 6, 7, 8, 9, and 10 years**, respectively, all with **publication years starting in 1980**, we identified in each of the six sleeping periods all articles either 'in deep sleep' or 'in less deep sleep'. Next we investigated the 'awake intensity' in a four-years period immediately following each of the six sleeping periods. More particularly, we investigated whether they belong to one of 5 'awake intensity classes'.	The total number of publications in the data-system increases from 656,991 in 1980 to 1,046,839 in 2000. It is **clear that the more publications are published in a given year, the higher the probability of SB**. This higher probability also works at the 'citing side': **the more publications are available as citing papers in later years**, **the higher the chance that a publication of an earlier year will be cited**. From our total set of measurements we were able to derive a general <u>**'Grand Sleeping Beauty Equation':**</u> $N = f \{s, cs, cw\} \sim s^{-2.7} \cdot cs^{+2.5} \cdot cw^{-6.6}$ which gives the number of SB for any sleeping time, sleep intensity and awake intensity, and particularly the dependency on these variables. Of course, there are many more Sleeping Beauties if we decrease (1) the sleeping time, and/or (2) the depth of the sleep, and/or (3) the awake intensity.	Further work is necessary to analyze the statistics of **Sleeping Beauties for different fields** and to <u>study the possible influence of specific (types of) journals.</u>