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The evolution of the commercialization of Knowledge with New Approach of Referenced Publication Years Spectroscopy (RPYS)

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Abstract

The purpose of this study was to identify the most important historical works written in the field of commercialization of knowledge using Referenced Publication Years Spectroscopy (RPYS). Initial data were obtained from the Web of Science (WoS) database to investigate the historical roots of published works in the field of commercialization of knowledge. Then, the main roots of this filed, the amount of received citations, and influential works were identified using RPYS software. Next, with the help of the *yearcr* software, the extent of the effects of the works outside of the range of peaks were also introduced. The period under investigation is the publication in the years 1900-2015. by searching published works in the time period of 1900-2015, 1550 records related to commercialization of knowledge were retrieved. To exactly investigate the effects of this field, the timeframe was divided into five periods (four 25-year periods and one 15-year period) to allow peaks with a small number of citations in the early years. The total number of citations up to the time of the present research was 39817, which resulted in the emergence of five peaks in the years 1934, 1962, 1973, 1998, and 2003.

Keywords: Commercialization of knowledge, Knowledge Management, Scientometrics, Referenced Publication Years Spectroscopy

Introduction

Knowledge is the main factor to create added value, wealth generation, economic growth, and comprehensive development in current societies. The approach of modern societies in generating capital from knowledge, and to some extent, using knowledge to reach competitive advantage and playing a role in comprehensive development is clearly visible. The tendency to generate capital from knowledge has led to the commercialization of knowledge in various forms. Commercialization are applied under various titles and in various fields, such as commercialization of technology, commercialization of research results, commercialization of innovation, entrepreneurship, entrepreneurial university, knowledge profitability and the like. Due to the fluidity of the field of commercialization of knowledge and its extension to other fields of human knowledge, it is no longer possible to discuss the issues of commercializing knowledge inclusively in one or more specific fields of knowledge, and often basic sciences. Knowledge of applied vocabulary, historical roots, scientific peaks, effective sources of information, and individual thinkers in the field of commercialization of knowledge is one of the factors that can help to better identify the works and ideas in this field and their impact on other fields of human knowledge. Wray (2013) believes that bibliographic data has the potential to reveal the nature and structure of scientific research communities (Soheil & Khasseh, 2015).

One of the modern methods of discovering the historical roots of the scientific fields, is the quantitative method of "Referenced Publication Years Spectroscopy" or RPYS, which has been introduced by Marx, Bornmann, Barth & Leydesdorf (2014) in the field of scientific historiography.

The method of RPYS is based on the analysis of the frequency of references that are cited in the scientific production of specific fields, and also based on the year of publication. The analysis of the list of references cited with the emphasis on the year of the publication of these resources could result in the disclosure of historical and prominent roots in a specific research field.

In this method, the roots can be represented by the creation of, so that the peak points of these curves depict the years when the published works of that year have been frequently cited. Once these factors with important role in the formation of the relevant field are identified, it is necessary that the published works of each year be individually examined and their contribution to the formation of the field under study be determined (Khasseh & Mokhtarpour , 2016; Marx et al., 2014).

Using RPYS, it is possible to identify the historical roots of research fields and to investigate the effect of these origins on current research. This method is based on the analysis of the frequency of citation to references) in the works of a particular research field according to the year of publication.

RPYS is able to extend its review to decades or even centuries, and thus better capture the evolution of a field. Due to novelty of the discovery of the historical roots of the scientific fields by RPYS, few number of research has been conducted by this method. The research discovering the historical roots of scientific fields are as follow:

Leydesdorff & et al. (2014), analyzed the indexed documents in the Web of Science on the subject of scientism using the RPYS. The results of their research was published in an accredited jou**rnal and** led to the identification of some infrastructure works in the field of scientometric.

More precisely, the results indicated that the early roots of scientometry were formed between the 1920s and 1950s, and in particular under the influence of individuals such as Lotka in 1926, and thus intellectually influenced and gradually developed by topics such as the history of science (de Solla Price), a bibliographic couple (Michael Kessler), and a citation profile (Eugene Garfield).

Using RPYS, Marx et al. (2014) carried out a similar study on scientific productions with the topic of graphene and solar cells, and identified and analyzed the significant effects in these two fields.

Marx & Bornmann (2014) conducted a research showing that RPYS method can be used to discover the origin of scientific fiction. They investigated one of the bird species by RPYS method. It is known as Galapagos or Darwin finches which includes 15 species of sparrows but it's still unclear to which clan or subfamily these birds belong to. The results of the research showed that a book was written by Sulloway (1947), which was the most- citied old work in this field. Scientifically, Sulloway is the first person to discover the origin of the legend of Darwinian finches.

Wray and Bornmann (2015) used RPYS in the main journals of the philosophy of science. They came to the conclusion that most of the influential works in this field, unlike the basic sciences, had appeared in the form of the book. The results revealed 7 peaks between the years 1900 and 1970.

Soheili and Khasseh (2015) analyzed the list of available resources in 15663 scientific records related to information behavior using a software specific to RPYS. Their findings indicated that in the nineteenth century, the field of information behavior witnessed three important peaks occurring in 1876, 1879, and 1890, respectively.

Moreover, between 1900 and 1969, six peaks in the field of information behavior occurred in 1948, 1954, 1957, 1960, 1965, and 1967, respectively. After identifying and analyzing the influential works published in the aforementioned years, the researchers believe that the field of information behavior, has been affected by psychology and, to some extent, quantitative and qualitative methodological works (such as grounded theory and critical incident). Additionally, some theories and theoretical works have also influenced this field (Soheili & Khasseh, 2015).

Biranvand and Khasseh (2016) have carried out a research by scientometric method to investigate historical roots of Semantic Web. 4831 retrieved records have been analyzed using PRYS software. The distribution of the number of references available in the records of the field of Semantic Web based on the year of publication shows that, in the twentieth century, the field of Semantic Web witnessed six important peaks in 1962, 1965, 1975, 1979, 1983, and 1995 respectively. Generally and according to the findings of this research, it seems that the field of Semantic Web has been influenced by works of various topics such as linguistics, knowledge representation, and artificial intelligence.

Results of the research carried out by RPYS approach suggests the identification of fundamental and cited works in various fields. Identifying influential works and influential authors has a profound effect on the improving fundamental concepts and the formation of new works. For this reason, despite the novelty of RPYS approach to identify outstanding works and influential authors in each field, we are witnessing an ever-increasing research and introduction of scientific peaks on various subjects.

The present study aims to identify the course of scientific evolution in the field of commercialization of knowledge with the RPYS approach and to determine the time of occurrence of important peaks in the field of commercialization of knowledge, to determine the effective works in formation of scientific peaks in the field of commercialization of knowledge, and to determine the most- cited authors in the field of commercialization of knowledge during this research.

Methodology of research

This research has applied scientometrics to investigate the historical roots of the commercialization of knowledge. Initial data was extracted from Web of Science (WoS). The retrieved records ranges from 1945 to the end of 2016, which were recorded in the WoS citation indexes.

This period of time was chosen to retrieve the knowledge of the commercialization of knowledge, because it covered the particular version of WoS version from 1945 onward. The date to extract information from the WoS will be 2016-12-10. In the analysis of the resulting information, the researcher tries to compare the number of citations received from WoS with other accessible databases such as Google Scholar (scholar.google.com).

It is obvious that the number of citations in the Google Scholar database will be much more than the citation made in Web of Science database. In order to collect the initial data of this study, all articles related to the field of commercialization of knowledge in Web of Science database have been retrieved using the following search strategy:

TOPIC:("commercial knowledge") OR TOPIC:("commercial* science") OR TOPIC: ("commercial* research*") OR TOPIC: ("commercial* innovation") OR TOPIC: ("commercial* technology") OR TOPIC: ("Knowledge capitalization") OR TOPIC: ("science capitalization") OR TOPIC: ("research capitalization") OR TOPIC: ("technology capitalization") OR TOPIC: ("innovation capitalization") OR TOPIC: ("capitalization knowledge") OR TOPIC: ("capitalization science") OR TOPIC: ("capitalization research") OR TOPIC: ("capitalization technology") OR TOPIC: ("capitalization innovation") OR TOPIC: ("Bayh-dole act")*

1,555 records were retrieved using the search strategy above. The result of the review of the citations (sources) used in these records was obtained in two files, "rpys.dbf" and "median.dbf". The first one organized the number of citations per publication year, which can be used to plot the data spectrum and the second file also includes the median deviation of the number of citations per year over a five-year period (two years before, the year of publication, and two years later). Due to this five-year median deviation, the resulted curve represented available peaks in production of works of this field in a smooth and flat trend. In the next stage, after the spectroscopy of the curves generated in Excel, years of peaks were identified. Then, the number of citations related to the published works in these years, and other bibliographic information was identified using yearcr.exe software. Finally, the work identified by the topic experts would be analyzed.

Findings of the research

In order to provide consistent information, first, information on the number of citations made to each source is presented based on the year of publication in Table 1. To complete the information in Table 1, chart 1 was represented to allow spectroscopy of the historical trend of commercialization of knowledge and possible peaks in this field.

Since the basis of this study is citedness, not citingness, all references cited and registered in Web of Science database are introduced and studied. The lack of interesting citation source prior to 1900 resulted in investigating the time series from 1900 to 2015.

Since in chart 1, smaller peaks may not be observed compared to the larger peaks, this 115-year interval of was divided into five periods (1900-1924, 1925-1949, 1950-1974, 1975-1999, 2000-2015). Further details are provided with the related chart.

Scientific peaks in the field of commercialization of knowledge

Table 1 was represented to illustrate the historical trend of scientific production as well as citations in the field of commercialization of knowledge. As shown in Table 1, the amount of citations to resources in the field of commercialization of knowledge has experienced a nearly smooth growth up to the beginning of the second half of the twentieth century.
The change in the growth rate of resources in this field happened since 1962, following the social and political changes as a result of the end of the Second World War, and tendency of different societies to generate capital from knowledge, and also commercialization. The desire for investment in fields of modern technology, invention and innovations has boosted research works at academic level.

Table 1. The number of citations in resources generated on the basis of the year of publication in the period from 1900 to 2016

RPYS	RPY	RPYS	RPY	RPYS	RPY	RPYS	RPY	RPYS	RPY
2480	**2000**	120	**1975**	30	**1950**	3	**1925**	2	**1900**
2954	**2001**	164	**1976**	19	**1951**	11	**1926**	6	**1901**
3166	**2002**	221	**1977**	23	**1952**	18	**1927**	6	**1902**
3763	**2003**	189	**1978**	18	**1953**	15	**1928**	7	**1903**
3444	**2004**	227	**1979**	25	**1954**	23	**1929**	5	**1904**
3406	**2005**	210	**1980**	27	**1955**	24	**1930**	0	**1905**
3297	**2006**	203	**1981**	32	**1956**	11	**1931**	2	**1906**
3437	**2007**	316	**1982**	53	**1957**	13	**1932**	16	**1907**
2724	**2008**	352	**1983**	49	**1958**	15	**1933**	9	**1908**
2465	**2009**	326	**1984**	81	**1959**	40	**1934**	4	**1909**
2242	**2010**	374	**1985**	31	**1960**	5	**1935**	6	**1910**
2137	**2011**	571	**1986**	53	**1961**	6	**1936**	12	**1911**
1611	**2012**	478	**1987**	138	**1962**	13	**1937**	11	**1912**
1285	**2013**	603	**1988**	49	**1963**	5	**1938**	6	**1913**
877	**2014**	679	**1989**	53	**1964**	11	**1939**	8	**1914**
444	**2015**	967	**1990**	70	**1965**	5	**1940**	4	**1915**
85	**2016**	917	**1991**	78	**1966**	5	**1941**	9	**1916**
		821	**1992**	85	**1967**	19	**1942**	12	**1917**
		952	**1993**	102	**1968**	10	**1943**	5	**1918**
		1330	**1994**	66	**1969**	8	**1944**	1	**1919**
		1177	**1995**	70	**1970**	30	**1945**	14	**1920**
		1560	**1996**	84	**1971**	7	**1946**	15	**1921**
		1613	**1997**	113	**1972**	8	**1947**	5	**1922**
		2213	**1998**	186	**1973**	15	**1948**	8	**1923**
		1645	**1999**	127	**1974**	17	**1949**	10	**1924**
39817	total	18228	total	1662	total	337	total	183	**total**

*RPY represents the year under review. The RPYS represents the number of citations made to the sources of the year under review.

Information about the years prior to 1900 has not been represented due to the very few number of citations and scientific production. Moreover, since in RPYS method, the median deviation of the number of citations per year has been represented in a five- year period (two years before, the year of publication, and two years later), the years leading to 2015 and 2016 are also not being investigated. Due to the new resources produced in 2015 and 2016, the information during this period of time has been excluded.

Table 2. Historical peaks in the field of commercialization of knowledge with the most-cited works in the period of 1900-2015.

Peaks	Total number of citation	Most-cited works	Number of citation for each work	Kind of work
1934	40	*Schumpeter, J. A. (1934)*	30	Book
1962	138	*Arrow ،Kenneth J(1962)*	48	Article
1973	186	*Merton, R. K. (1973)*	54	Article
1998	2213	*Henderson ،Rebecca ،Adam B. Jaffe Manuel Trajtenberg. (1998)*	124	Article
		Etzkowitz, H., Webster, A. & Healey, P. (1998)	107	Book
2003	3763	*Siegel ،Donald S. ،David Waldman & Albert Link. (2003)*	177	Article
		Di Gregorio ،Dante و Scott Shane. (2003)	126	Article

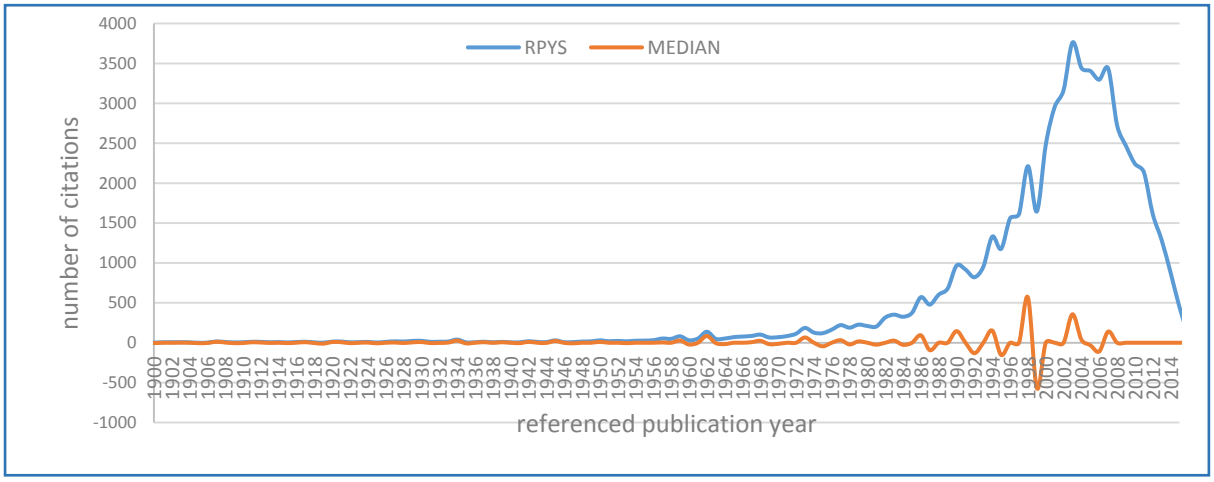

chart1. Findings of RPYS in the field of commercialization of knowledge field (1900-2015)

Chart 1 aims to illustrate the growing trend of citation in the field of commercialization of knowledge in the time period of 1900-2015. The increasing trend of citation for the year 1962 onward can be observed in this chart. This growing trend started by a peak occurred in 1962 and under the influence of works in this period of time. The gradient of the chart shows a great increase in the number of citations from this date onwards.

The major peaks in the chart1 is related to the years 1994, 1998, and 2003. But due to the fact that many of the small-scale scientific peaks may be ignored, the period from 1900 to 2015 was divided into four 25-year periods and one 15-year period, so that in a small scale, even peaks with fewer citations can be displayed. For example, in chart. 1, the peak related to the year 1962, 1973, and other similar cases cannot be observed. However, by dividing this chart into smaller periods, these peaks is observable.

The frequent mistakes occurring in this statistical comparison is to combine the entire time period in form of an overall chart and to compare all the years under examination in form of a single chart. In this method, many of the small scientific peaks are ignored; therefore, as it will be seen, the 115 year period studied (1900-2015) is divided into four 25 –year period (1900-1924, 1925-1949, 1950-1974, 1975-1999)) and one 15-year period (2000-2015). The image related to the periods under study are as follows.

- The period of 1900-1924

According to the chart 2, there is no specific peak in the field of commercialization of knowledge during the years 1900-1924. According to the results from the Web of Science database, the total number of citations to the works produced during this period is 183 (Table 1).

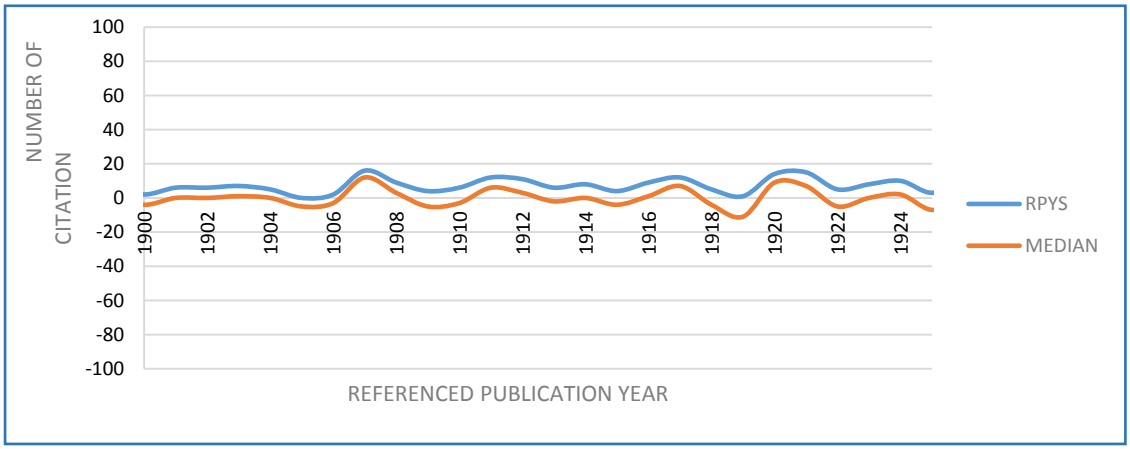

Chart 2. Findings of RPYS in the field of commercialization of knowledge (1900-1924)

- The time period of 1925 to 1949

Based on the information extracted from the Web of Science database, 366 works have been produced in the field of commercialization of knowledge during 1925-1949. The most significant scientific peak occurred in 1934. Although the number of citations to this work is not impressive compared to the subsequent periods, it can be considered as a peak compared to the time period and the number of resources produced during that period. The total number of citations to the works produced in this year is 40 citations. The book "The Economic Development Theory" by Schumpeter has included 30 citations.

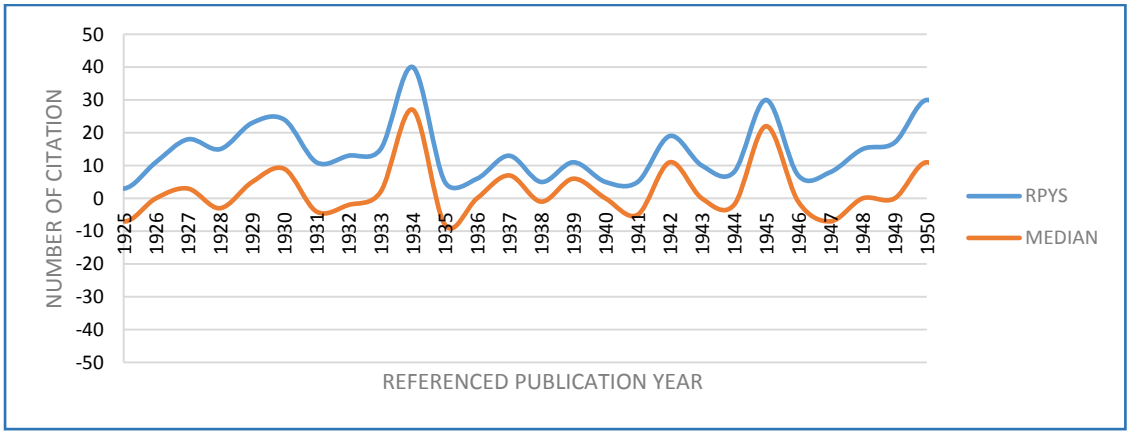

Chart 3. Findings of RPYS in the field of commercialization of knowledge (1925-1949)

- 1934: The total number of citations to the works produced in this year is 40 citations, of which 30 cases are related to the book "The Economic Development Theory" by Schumpeter with the following bibliographic specifications:

> - Schumpeter, J.A. (1983). The theory of economic development: an inquiry into profit, capital, credit, interest, and the business cycle. New Brunswick, N.J: Transaction Books.

Schampeter's Economic Development Theory (1950-1983) is one of the early masterpieces in economics, knowledge management, and entrepreneurship, which has had a great deal of influence on the following compilation works. This work is one of the most- cited works of the field of economics, knowledge management and entrepreneurship, which, despite the passage of more than 80 years since the publication of the book, it remains one of the most famous and most influential works in the field of knowledge management. It is more than 9 times edited and cited in 33697 times in various sources (Google Scalar, Access on 23/2/1396). This book emphasizes the need to distinguish between internal and external factors affecting the development cycle.

He believes that economic growth and development will be possible when some individuals among the communities take risk to innovate and thus replace new and effective methods and solutions with previous inefficient and inferior solutions. Therefore, from the point of view of Schumpeter, development originates from initiatives of the system itself (Schumpeter, 1934, p. 63), rather than from external factors. Schumpeter, considers the innovative and entrepreneurial-based economy a good alternative to the capitalist economy of that time.

Schumpeter regarded Innovation as the driving force behind the development of economics, and perhaps that is why Ma Craw (2007) has interpreted him as "the Prophet of Innovation". From the point of view of Schumpeter, knowledge is an internal factor derived from the individual and group experiences of people within the companies (Khasseh and Mokhtarpour, 2016, p. 1397). Following the intellectual challenges of the nineteenth and early twentieth centuries, in which the economic competition between industrialized nations became more serious and applied aspects of the economy became the center of attention, Joseph Schumpeter emphasized the role of knowledge in innovation and the dynamics of the economy, introducing it as the basis of entrepreneurship and transformation of economy.

The period of 1950-1974

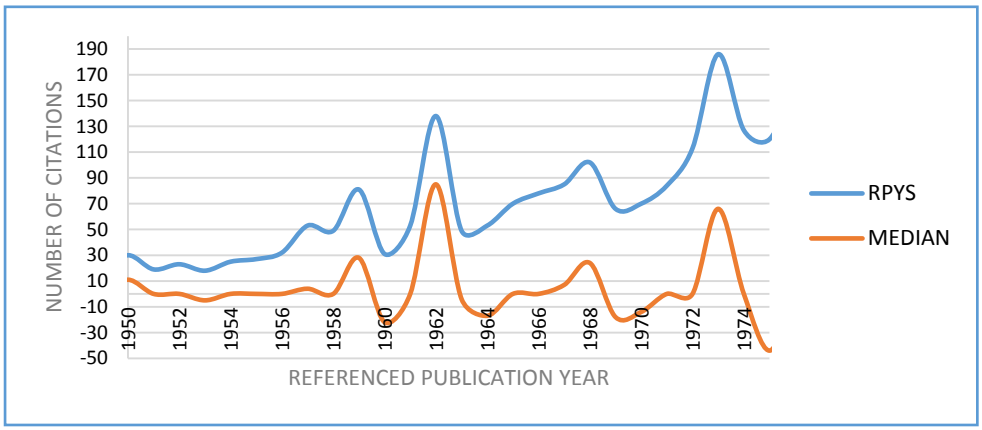

Chart 4. S findings of RPYS in the field of commercialization of knowledge (1975-1950)

The results of RPYS in the chart 4 revealed two scientific peaks in the years 1962 and 1973.In each of the above mentioned works, the most citations have been represented:
- 1962: the works related to this year have been cited 138 times, of which 48 cases (34%) are related to the article by Kenneth with the following bibliographic specifications:

- Arrow, Kenneth J. (1962). The Economic Implications of Learning by Doing. The Review of Economic Studies. 29 (3), 155. DOI 10.2307 / 2295952
- Kenneth (1962) regards the tendency to learn as the basic factor in acquiring knowledge. He has introduced the endogenous theory in knowledge as the reason of temporary and international changes in production functions.

From his point of view, learning is the result of experience and the attempt to solve a problem in the most effective form of learning. In order to enhance the performance, the stimulus should be continually in evolution, not merely in repetition. In the present article, Kenneth investigated the role of experience in increasing productivity.

As Kenneth suggested, the role of knowledge made out of experience constitutes the main body of economic theory to increase productivity. By yearcr software, it became clear that other works published this year did not play a significant role in receiving citations and each of them has been cited only once.

1973: The works of this year have been cited 186 times, of which 50 citations (27.9%) are related to the book *The sociology of science* by Merton with the following bibliographic specifications:

- Merton, R.K. (1974). The sociology of science: theoretical and empirical investigations (4. Dr.). Chicago: Univ. Of Chicago Pr.

The book *The sociology of science*, by Merton is the result of forty years of work on articles in the field of sociology of science. Robert Merton's main focus in sociology of science is introducing social conditions and the facilitating the search for scientific knowledge. This work is one of the important works of sociology and especially sociology of science, whose writings represent the modern sociology of science. Rovetz considers the book "Sociology of Science" by Merton as a professional and effective work in the field of sociology of science. Philip Morrison also regards Merton's work as a historical work in the field of sociology for his scientific analysis and influence.

- The period of 1975-1999

RPYS related to the works in the field of commercialization of knowledge in the time period of (1975 – 1999) shows an increasing smooth trend (chart 5). The peaks made during this period are 1998 and 2000.

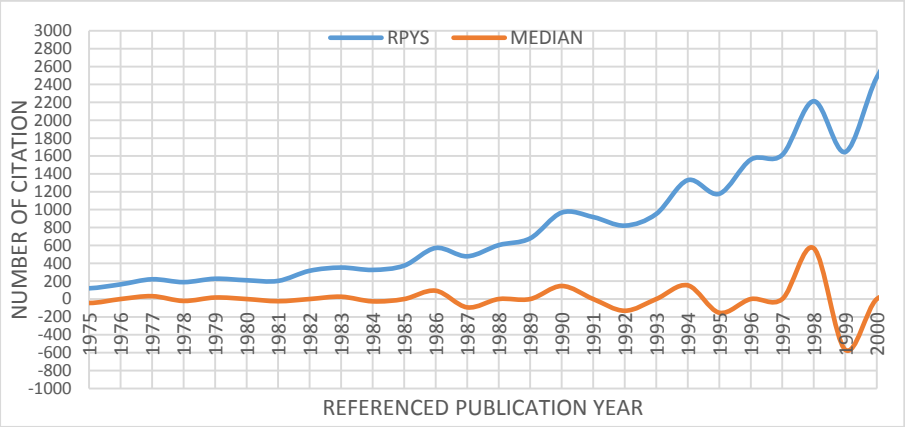

Chart5. The result of RPYS in the field of commercialization of knowledge(1975-1999)

A main peak occurred in the period of 1975-1999.

1998. Of 2234 citations to the works related to this year, the article" Universities as the sources of technology commercialization, by Handerson with 124 citation, the book" the knowledge of investment: the intersection of university and industry" by Etzkowitz with 107 citations are the most-cited works in this year. Bibliographic specifications of the above mentioned works are as follows:

Henderson, Rebecca, Adam B. Jaffe & Manuel Trajtenberg. (1998). Universities as a source of commercial technology: a detailed analysis of university patenting1965–1988. Review of Economics and statistics. 80(1), 119-127.

- Etzkowitz, H., Webster, A. & Healey, P. (1998). *Capitalizing Knowledge: New Intersections of Industry and Academia*. SUNY Press.

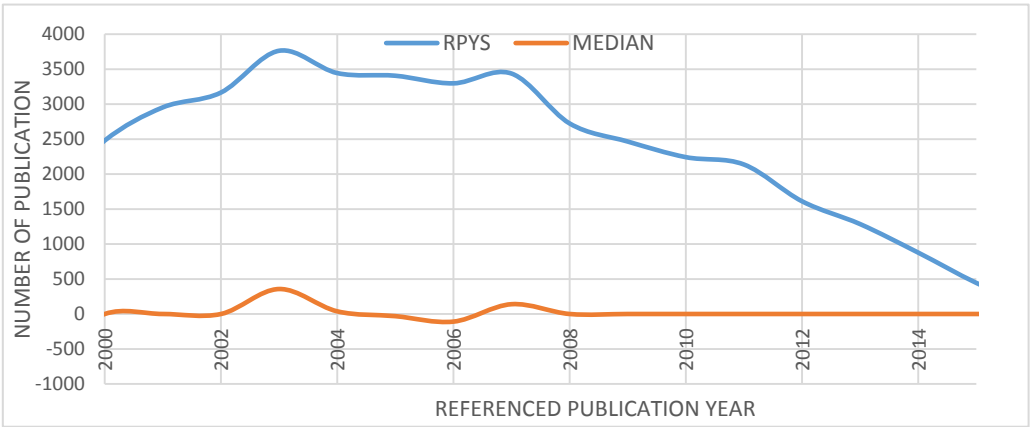

Chart6.findings of the RPYS in the field of commercialization of knowledge(2000-2014)

The highest number of citations in the field of commercialization of knowledge occurred this period (2003). As shown in chart 1, a major peak in this amount of citation to the works related to the commercialization of knowledge has occurred this year. This amount of citation is unprecedented compared to the previous and subsequent years. The tendency of societies to investment in the field of knowledge and the issues of commercialization of knowledge has increased the production and consequently scientific citations.

- 2003: 3763 citations to the works related to this year have been made. 177 citations to works by Siegel (2003) have been made, among which the most cited work is "Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study" with 119 citations (3.17 percent). The bibliographic specifications of of this work are as follows:

> Siegel, Donald S., David Waldman, Albert Link. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. Research policy. 32(1), 27–48. http://www.sciencedirect.com/science/article/pii/S0048733301001962

In this paper, Siegel investigated the role of university technology transfer offices. From his viewpoint, the most important factors affecting the transfer of technology were rewards, professional human force, and compensation methods, and cultural factors among universities. Generally, 4.73% of the total citation in 2003 belonged to Siegel, while the above-mentioned article alone accounts for 11.3% of this amount of citation.
The second most-cited work in this year with 118 citations (12.3%) is:

> - Gregory, Dante & Scott Shane. (2003). Why do some universities generate more start-ups than others? Research policy 32 (2), 209-227.
> Http://www.sciencedirect.com/science/article/pii/S0048733302000975

In various sources, the author's name is in three different forms: disgregorio, di d. Gregorio, and gregorio d, the dominant form of which is Di Gregorio, D. Grigory In this paper, studied the implications of technology offices of university. He considered the following factor as the important factors in establishing such offices in universities:

The investment in the academic research sector, the growth of commercialization research in universities, policies of investment and stocks in technology offices.

Discussion and Conclusion

Considering the approach of producing capital from the knowledge created and available in academic centers, the commercialization of knowledge is one of the interdisciplinary majors. it can be cited in different fields such as knowledge management, economics, entrepreneurship, etc by investigating the historical trend of publication of created works. It is noteworthy that the opposite of this case is not always true, which means that a work may be about knowledge management, but not related to the commercialization of knowledge. Therefore, it is obvious that the amount of citations and consequently the peaks in the areas of knowledge management and entrepreneurship are much more and more intense than the commercialization of knowledge.

For example, in a study by Khasseh&Mokhtarpour (2015) entitled "Tracing Historical Origins of Knowledge Management Issues through the Reference Journal of Publication Spectroscopy (RPYS)" in the Web of Science, it is revealed that book by the Schumpeter entitled "The theory of economic development : An inquiry into profits, capital, credit, interest, and the business cycle "received 135 citations. While according to this survey, 30 citations has made to this work in the field of commercialization of knowledge. Therefore, the amount of citation to specific works can be categorized under two main or side factor of availability of the field under investigation and investigated database.

In examining the amount of citation to the works related to the field of commercialization of the knowledge, the first peak belongs to Schumpeter, J. A in the year 1934 with 30 out of 40 citations. However, in some cases, the name of this author can be seen as Champeter, J.A. Of the 19 works cited this year, there are 5 works related to the Scampeter. This can be the reason why the maximum number of citations belongs to this author **.**

The most influential work is "The theory of economic development: an inquiry into profit, capital, credit, interest, and the business cycle", which is on knowledge management and has been edited more than 9 times and has been cited in 33697times in different sources (Google Scholar, Access on 23/2/1396).The Schumpeter in this book emphasizes the necessity to distinguish between internal and external factors affecting the development cycle.

A thoughtful point about peaks with few citations in knowledge sub-domains is that commercialization is subsidiary compared to the more general fields such as knowledge management, entrepreneurship, economics, and management and that is the reason for few number of citation. Therefore, compared to the studies carried out on different fields, this amount of citation is not significant and cannot be regarded as a peak.

The second peak occurred in 1962 with 138 citations. Of the total citations of this year, the article Arrow by Kenneth J (1962), with 48 times citation, alone accounts for 34.7 percent of the total number of citations to the works in year. In his article "The Economic Implications of Learning by Doing," Kenneth explores the effect of learning and experience on increasing the productivity. 4 out of the 65 works cited this year belonged to Kenneth. In references citing

Kenneth, 3 forms of Aarow KJ, Arrow K.j., and Arrow Kenneth J have been used. Therefore, to access all citations, all three forms should be considered.

The third peak occurred in 1973 with 186 citations. Of the total citations to the works of this year, Merton's book (1973), entitled " *The sociology of science: theoretical and empirical incvestigations*" on the sociology of science has been cited 54 times, which is 29.03% of the total citation. Of the 93 cited works related to year 1973, 16 works cited the book by Merton.

The fourth peak in the field of commercialization is related to 1998 with 2213 citations. The influential works in this period are: Henderson, Rebecca, Adam B. Jaffe & Manual, Trajtenberg (1998), entitled "Universities as a source of commercial technology: a detailed analysis of university patenting 1965-1988", with 124 times citation, and the book "Capitalizing Knowledge: New Intersections of Industry and Academia" by Etzkowitz, H., Webster, A. & Healey, P. (1998), with 105 citations. The dramatic increase in the number of citations and scientific publications in this period is directly related to Bayh-dole Act, one of the most well-known laws on the commercialization of results of academic research. Bayh-dole law was approved in 1980 in the United States.

This law transmits intellectual property ownership from public funding providers to universities and emphasizes policy changes that directly involve universities in industry development (Link, Siegel & Bozeman, 2007). However, it has not been the only factor to increase the commercialization of academic research (Kortum and Lerner, 1999, p. 369). Increasing the amount and complexity of scientific research, increasing the competition among scientists, using commercial activities such as patents and startups were effective in ranking the universities to make this change in academic culture (Kumar, 2010, p. 329).

Demand from the community for scientific research, increasing competition among scientists, and using business activities including patents and startups have been effective as a measure for ranking universities to make this change in academic culture

As a result of Bayh-dole Act and factors above, supporting economic growth become the "third mission" of American universities - accepting the role of universities in the commercialization of knowledge - including business activities such as patent, licensing and company establishment besides training and research (Baldini, 2006).

The fifth peak, the highest growth over the history of this field, in the citation rate of the works related to the field of commercialization of knowledge dates back to 2003. The number of citations made to the works in the field of commercialization of knowledge at the WoS database in 2003 at the time of this research was 3763, of which the most-cited works were the article "Assessing the impact of organizational practices on the relative productivity of university technology Transfer offices: an exploratory study "by Siegel et al. with 119 citations, and the article" Why do some universities generate more start-ups than others? " by Gregorio, Dante & Scott Shane with 118 citations respectively. The two papers accounted for 28.6% of the total citations made to the works in 2003.

Other writers like Etzkowitz (2003) with 99 citations, Otero (2003) with 73 citations, and Friedman (2003) with 64 citations gained the next places. The large number of citations in 2003 were made followed by the increase in the trend of previous periods and the significance and importance of commercialization of knowledge in recent years.

The results of the present study shows that along with the growth in capitalist thinking and the tendency to capitalization through knowledge sources in different societies, an increase is witnessed in the number of sources that discuss the commercialization of knowledge and the production of wealth from knowledge. Resources production has a slow trend at first. However, in 1980s it started a new life by approving Bayh-dole Act in USA and paying attention to the intellectual property ownership. Moreover, since the entry of the university into the field of commercialization of knowledge and the results of academic research, establishing science and technology parks, the growth and entrepreneurship centers, industry relation offices, we are witnessing increasing attention of academic communities to the field of commercialization of knowledge and capital production and accordingly, independency to state outcomes.

The increasing trend of citation to the works related to the field of commercialization of knowledge has continued until 2003.From 2003 on, due to the fact that the works produced are young, the number of citations did not have a significant increase. It is expected that in the future we will see more and more intense peaks in the amount of citations in the works of this period. Certainly, future studies will show an ever-increasing growth in the number of citations in the field of commercialization of knowledge. The results of investigating the evolution of commercialization of knowledge with the new RPYS approach show that the field of commercialization of knowledge is affected by the fields of knowledge management, economics, entrepreneurship, and sociology of science.

Obviously, due to the interdisciplinary nature of commercialization of knowledge, the articles related to this fields can be published in journals of other disciplines. These journals receiving works in the fields of commercialization of knowledge have diversity and varicosity, which leads to the disability to identify the core journals focused on this topic. However, it can be a good opportunity for researchers and authors in this filed since the lack of dependence on a couple of journals for the production of published articles can reduce the particular stress that authors tolerate to publish their work.

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