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Innovation and Interactions:

A Bibliometrics Study on intra-firm Coordination

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ABSTRACT

The way the firm uses its technological resources and competences, the ability to combine/recombine components, methods, processes and techniques to offer products and services plays a central role on the innovation process (AFUAH, 2002). As Indarti (2010) points out, the interactions are a key element in the process of gaining access to, acquire, and develop knowledge for the stimulation of a firm's activities in the field of innovation. From the intra-firm perspective, to innovate, Paruchuri (2010) argues that a firm that can improve the diffusion of knowledge internally will benefit from enhanced innovative activity. Aalbers (2015) reflecting on the governance of knowledge sharing inside organizations, suggest that knowledge may come to be difficult to transfer because of the boundaries dynamics. In light of these authors insights the aim of this paper is to present an overview of the research regarding Interactions, Innovation and Intra-firm Coordination. For that, we performed a bibliometrics study within the Web of Science (WoS) and the Elsevier's Scopus libraries. A final sample of 111 papers were built after several refinements. The results suggest a growing tendency of the publications on the subject. The most cited papers have a gap of almost twelve years in between it, which shows that the construction of knowledge, about the topics innovation interactions and intra-firm coordination are still attached to what was published a long time ago, for the initiators of this research field, but the works of Dolfsma et al (2008) and Leendert et al (2015) shows us a new trend and that new researchers are using these brand new works as references to perform new studies.

Keywords: *Innovation, Interactions, Coordination, Intra-firm, Bibliometrics*

1. INTRODUCTION

From the works of Joseph Alois Schumpeter until today, innovation is recognized as the process of renovation of the firm, ensuring its survival and success. In addition, with a constantly fluctuating environment the firm requires technological innovation and managerial response to remain competitive (WANG et al., 2008). Thus, the way the firm uses its technological resources and competences, the ability to combine/recombine components, methods, processes and techniques to offer products and services plays a central role on the innovation process. (AFUAH, 2002).

The Interactions have a significant impact on a firm's success. According to Sorge and Warner (1987) the success of a firm largely depends on the quality of its relations inside the firm and with external organizations. Interactions with other firms enables a firm to obtain resources, such as knowledge (i.e., know-how), materials, services, personnel, and capital, which are required to achieve its commercial goals and meet the interests of the external and internal stakeholders.

As Indarti (2010) points out, the interactions are a key element in the process of gaining access to, acquire, and develop (new) knowledge for the stimulation of a firm's activities in the field of innovation. Interaction with other firms enables organizations to absorb knowledge from external parties more effectively, and use it for creating new goods/services. Interactions can take place within a firm as well as between a firm and other organizations.

From the intra-firm perspective, to innovate, Paruchuri (2010) argues that a firm that can improve the diffusion of knowledge internally and this will benefit to enhance the innovative activity. Aalbers (2015) reflecting on the governance of knowledge sharing inside organizations, suggest that knowledge may come to be difficult to transfer because of the boundaries dynamics. These dynamics can create a reluctance to share knowledge with individuals from other units. Several authors, such as Hansen (1999 & 2002), Cross (2003 & 2004) and Aalbers (2015) argues that the researchers largely focus on knowledge flow inside a firm as be on individuals, irrespective of their position in the organization and end up often ignoring firm-internal unit boundaries as possible hurdles for knowledge to be transferred.

In light of these authors' insights the aim of this paper is to present an overview of the research regarding Interactions, Innovation and Intra-firm Coordination. For that, we performed a bibliometrics study within the Web of Science (WoS) and the Elsevier's Scopus libraries. The analysis includes the evolution of publications over the past ten years, most cited papers, authors, main journals and its citations. We also identified trends in themes, methods and theoretical background of the top five most cited papers within our sample, to provide a direction to where the future researches may follow. In the following sections, we present our definitions, method and results.

2. DEFINITIONS

In this section we present all the definitions we used in to perform gather the papers that were used in the analysis. These are Innovation, Interactions and Intra-firm Coordination.

2.1. Innovation

In the context of a changing environment with a constant search to increase and maintain the competitive advantage, innovation emerges as the fundamental process of renovation of the firm, to modify the way it offers and delivers its goods and services. (ROSENBERG, 1986).

Schumpeter in 1912 was the precursor to the understanding of innovation as a stimulus for economic development and as a factor of success of firms, an approach that was later followed by several authors. For the author, innovations emerge when the firm represented by the figure of the entrepreneur or, in the current context for the R&D department associated, discovers new ways of combining the factors of production that generate extraordinary profits to the firm. In a broader sense, the author states that what keeps the economy going is the release of new products, new production methods, new forms of organization and new markets (SCHUMPETER, 1978).

Currently, the concept of innovation is associated with changes in processes and products in order to solve problems of production and marketing, through the implementation and transformation of scientific and technical knowledge, always aiming to profit (FREEMAN, 1994). Zawislak (2008) supports this view by stating that innovation is defined as "any and all of the firm's organizational change through the application of new knowledge (...) which results in products recognized as superior, i.e. that are generating profit."

The innovation process that generates new products or services is largely recognized in the literature as one of the most visible types of innovation and as a source of competitive advantage (CHRISTENSEN, 1999; COOPER, 2001). However, the firm's innovations include other junctures, such as:

- a. Introduction of a new product or service in the market or the transformation of an existing asset;
- b. Introduction of a new production method, previously unknown by the industry, or a new way of handling a product commercially;
- c. Opening of a new market for the industry in question, existing or not;
- d. Capture of a new source of raw materials or new suppliers;
- e. Establishment of a new form of organization of the industry, changing the positions of existing domain (SCHUMPETER, 1978).

Briefly, according to Schumpeter (1978), to generate value, translated here as superior performance in the market, the firm must create something different, but that should be recognized by the market as such. For this, the firm must understand an internal effort of creating, transforming the knowledge available in a technological change, which necessarily must be the transaction value, thereby generating extraordinary profits. This internal effort of managing existing knowledge and the search for new knowledge that can enable technological change is what provides firms with technological capabilities to innovate.

2.2. Interactions and the Intra-firm Coordination

The theory of interactions is well known for trying to understand people by its behaviors and environmental contexts. According to Becker (1974), the primary way of understanding others is by understanding their minds through the embodied interactive relations. Indarti (2010) and others argues that Interactions are a key element in the process of gaining access to, acquire, and develop (new) knowledge for the stimulation of a firm's activities in the field of innovation. In other words, interactions with other firms enables organizations to absorb knowledge from external parties more effectively, and use it for creating new goods/services.

To Salancik (1978), in order to realize its commercial objectives and expand its innovative activities a firm need to develop its own knowledge or acquire knowledge through the interactions within its own environment. Lundvall (1985) was one of the first to point-out the advantages of interacting and the interactions as a big construct. The author put interaction defined as a 'mutual or reciprocal action' it refers to a continuous two-way transfer of information between two parties who have a close relationship. The idea of interaction as a two-way effect, opposed to a one-way causal impact, was present in the work of Wagner (1994). In the various sciences, interaction has differently tailored meanings. In a social perspective, Dyer (1996) argues that spatial and cultural proximity plays an important role in the formation of the informal network.

In the context of intra-firm coordination, the role of interactions is highlighted by Foss et al. (2010), the author suggest that knowledge may come to be sticky to transfer because of the dynamics among firm's groups. These ingroup-outgroup dynamics can create a borders to share knowledge with individuals from other groups. While stickiness of knowledge is related to the social embeddedness of those who might partake in knowledge transfer, this intra-firm dynamic of knowledge exactly crosses boundaries that has not been the subject of much scholarly attention.

The importance of intra-firm coordination is discussed at the work of Paruchuri (2010), the author states that a firm that can improve the diffusion of knowledge internally will benefit from

enhanced innovative activity. Even as firms are urged to more readily allow innovative knowledge to cross firm boundaries, innovative knowledge may not easily move to where it can be used in the firm, however (AALBERS et al., 2013).

In an example of how complex the intra-firm coordination is, Henttonen (2010) argues that, in the multiple networks that constitute a firm, an individual employee may be relatively more internally orientated in one network while being relatively more externally oriented in another. A firm that seeks to benefit from enhanced innovative activity have to manage its intra-firm coordination, in a way that the interactions can provide boundaries that makes the knowledge flow in a proper way within its domain. The success of intra-firm coordination is deeply related on how the firm manage its interactions and provide opportunities to the innovative behavior rise.

3. METHOD

To achieve the objective of this study we proceed a bibliometrics study within reliable libraries, searching for an overview of the evolution, most cited authors, publishers and fields of study.

Today, bibliometrics is one of the rare truly interdisciplinary research fields to extend to almost all scientific fields. Bibliometrics methodology comprises components from mathematics, social sciences, natural sciences, engineering and even life sciences. It can be defined as the analysis of the scientific outcome published, for example by a researcher, a research team, an institution or country. It can further be specified by scientific discipline. The scientific outcome can be in a number of forms such as books, book chapters, a journal article, a contribution in a newspaper etc. One can label this strand of analysis the counting of publications. This provides information on quantity, but it does not provide it a relative use nor does it tell anything about the scientific use or impact. (THANUSKODI, 2010)

As it is rather difficult to obtain a picture of all scientific outcome, bibliometricians tend to use a dedicated database. For more than 40 years, the main database for analyzing the scientific performance of researchers was the Science Citation Index (SCI), starting in 1963, and the Social Science Citation Index (SSCI), starting in 1973. The Arts & Humanities Citation Index followed in 1978. All indexes were developed and maintained by the Institute for Scientific Information (ISI), which is now owned by Thomson Reuters. The main idea behind such an index is to collect citations of scientific articles. The database thus contains several thousand journals, and provides citation counts between these journals. The more a journal is cited, the higher its scientific impact. Thus, we chose to perform our study in the two largest libraries with the SSCI index, Scopus and Web of Science.

3.1. Data Sources

Hence we have our methodology chosen we had to set the population of the study, the terms Innovation, Interactions and Intra-firm Coordination are used among many fields, so our main scope was to choose libraries that covers different fields. In this sense, we found Scopus and Web of Science as a database that can cover this diversity, besides having the largest amount of paper collection in the whole world.

Scopus is database owned by Elsevier and is considered the largest abstract and citation database of peer-reviewed research literature. According to its website, Scopus is provided with tools to offer a quick, easy and comprehensive resource to support research needs in the scientific, technical, medical and social sciences fields as well as arts and humanities. Considering November 2012, Scopus has in its files more than 20.500 titles form more than 5000 international publishers, what means about 49 million records since 1823. Approximately 2 million new records are added every year via daily updates.

Web of Science is a citation database owned by Thomson Reuters that provides support for researchers in sciences, social sciences, arts and humanities, covering data across more than 250 disciplines, with coverage to 1900. Its website says that Web of Science is “the world’s most trusted citation index covering the leading scholarly literature.” The multidisciplinary content of the database covers over 12.000 of the high impact journals worldwide and over 150.000 conference proceedings.

3.2. Assignment Criteria

To perform the analysis, we first assumed several rules to the sample gathering, these rules were:

- Search Protocol: Scopus and Web of Science allows us to create and use our parameters to within their search engine. We established a simple parameter that made possible to search the terms “Innovation”, “Interactions” and “Intrafirm Coordination”, only and just when used together, in the same paper, since we do not want to consider papers where only one of the terms are used, for this, we already have books and seminal authors. We perform the search with all the possible typos within the terms i.e. “Intra-firm” and “Intrafirm”. We also exclude conference papers, reviews, essays and undefined documents.
- References published in newsletters were not consider as scientific literature, so, we have them excluded from the sample.
- All references were considered independent on their year of publication and its journal’s impact.

Thus, after we remove six papers that were included in both libraries we had our final sample, composed by 111 (40 from Web of Science and 71 from Scopus) papers published between 1979 and 2015.

3.3. Possible Sources of Error

While efforts were made to avoid errors by combining both manual and computerized procedures, the quality of the original data cannot be guaranteed if the main sources of failures are still data input errors. If volume/page numbers are omitted and irregular and cryptic journal abbreviations are used, an assignment to the correct reference-type category is made impossible. Another factor lies in the standards used by certain journals. It may happen that some journals use different types of citation index, making difficult to create a standard to analyze.

3.4. Analysis Tools

For this study we used several softwares to prepare the sample and to perform the data gathering, such as: Endnote X7, Procite 5.0 and Mendeley. To perform the tests, we used Ucinet 6.0 software, MS Excel and Citespace. Descriptive statistic was used to analyze the evolution of the papers, most cited journals, authors and nationality.

The analysis we performed are: Evolution of publications, Main authors, Main journals, Most cited papers, with a brief analysis of its content and most cited authors. These analyses are presented and discussed in the following section.

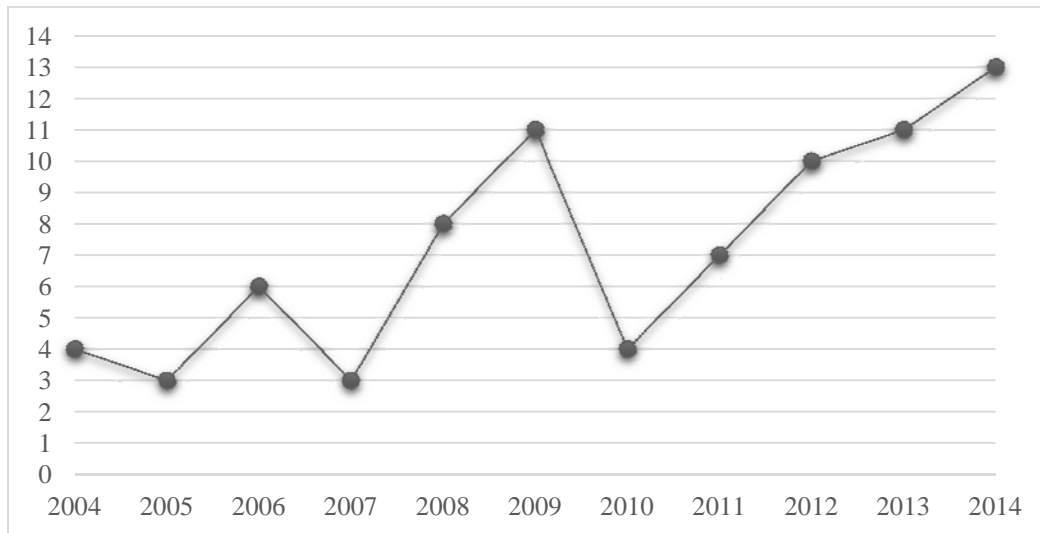
4. RESULTS

The first time the terms Innovation, Interactions and Intrafirm Coordination appeared simultaneously in papers was back in 1979, in the Scopus database. The next entry only appeared twelve years later, and until 1998 (3 papers) the production of articles was low. The first production peak appeared only in 2006, when the publication reached six articles.

Since 1998, the number of publications was alternating vicissitudes until 2004, when it reached the peak of four articles, exceeded in 2006 and later in 2009, which obtained the largest number of

historical publications back at the time. It is easy to see, according to the Figure 01, that there is a growing pattern on the themes together in the last five years. After a high peak in 2009, and besides the low peak at 2010, the publications started to grow and reached its peak in 2014. The year of 2015 was not considered in this particularly analysis because there are not conclusive results about the production of this year, but with a brief search, it is safe to assume that the trend will be a growth compared to the previous years.

Figure 01: Papers published per year. Innovations, Interactions and Intra-firm Coordination.



Considering the number of papers published per journal, using the terms together, the results shows that the journals with more papers are Research Policy and Journal of Knowledge Management of Knowledge Management. These two journals represent around 10% of all publications in the subject for both studied libraries, which compared to the other journals figuring at Table 01 can be considered a representative result.

It is safe to say that the publications with the terms are spread journals and not concentrated once that we have 94 journals with 111 papers spread along it.

The mean of citations per paper among all the listed journals are similar, going from 23 per paper to 35, which means that the citations generated by the main journals are almost the same regarding the themes without mattering the journal where it was published. Anyway we have to highlight a single seminal paper published by Tsai (1998) in the Academy of Management Journal that had 1191 citations until now, which makes the author the most important reference on the subject and the journal the most referenced within our sample, but with only one paper.

Table 01: Papers per Journal

Rank	Journal	Papers	Citations*
#1	Research Policy	7	304
#2	Journal of Knowledge Management	4	26
	Economics of Innovation and New Technology	2	70
	Journal of Business and Industrial Marketing	2	61
#3	International Journal of Innovation Management	2	56

* Sum of all the papers citations.

Among the authors who have published articles that relate the terms simultaneously, stand out the leader Battisti G. with six papers published and Stoneman P. with four papers published. No author has published more than 5% of all publications related to the topics, demonstrating that there are a large number of authors researching the issues (Table 02).

Table 02: Papers per Author

Rank	Author	Papers
#1	Battisti G.	6
#2	Stoneman P.	4
	David A.	2
	Dolfsma W.	2
	Machikita T.	2
#3	Malik K.	2
	Meyer-Krahmer F.	2
	Antonelli C.	2
	Chen Y.	2

In Table 03, we find a list of the five most cited papers of the final sample. The five most cited articles are divided in two periods, 1998-2003 and 2015, 1998 which were the first period of growth in the number of publications and the current year, where the subject is being more debated and exposed on the mainstream. The most cited article: "*Social capital and value creation: The role of intrafirm networks*" by Tsai, WP & Ghoshal, S (1998), has a percentage of 48.99% of citations. That represents a significant amount of the total citations, this occur due to the extreme relevance on the approach took by the authors, where they brought up the discussion that was not worked on the mainstream before, linking the value creation to the intra-firm interactions. Among the top rated papers, we have a gap of almost twelve years, which shows that the construction of knowledge about the topics innovation interactions and intra-firm coordination are still attached to what was published a long time ago. From the initiators of this research field until the works of Leendert et al. (2015) and Olander et al. (2015) all the evidences show us the field as a new trend and new researchers are using these brand new works as reference to perform new studies.

Table 03: Most Cited Papers

Rank	Authors	Title	Year	Source	Citations	%
#1	Tsai, WP; Ghoshal, S	Social capital and value creation: The role of intrafirm networks	1998	Academy Of Management Journal	1191	48.99
#2	Meyer-Krahmer, F; Meyer-Krahmer, F	Science-based technologies: university-industry interactions in four fields	1998	Research Policy	207	8.52
#3	Leendert Aalbers H., Dolfsma W.	Bridging firm-internal boundaries for innovation: Directed communication orientation and brokering roles	2015	Journal Of Engineering And Technology Management	160	6.58
#4	Simsek, Z; Lubatkin, MH; Floyd, SW	Inter-firm networks and entrepreneurial behavior: A structural embeddedness perspective	2003	Journal Of Management	60	2.47

#5	Olander H., Hurmelinna- Laukkanen P.	Perceptions of employee knowledge risks in multinational, multilevel organizations: Managing knowledge leaking and leaving	2015	International Journal Of Innovation Management	47	1.93
				Others	766	31.51%
				Total	2431	100%

The list of the most cited papers tells us that we are currently in a moment where the subject of intra-firm coordination and interactions to innovation is gaining attention again. The recent publications are attempting to manage the organizational behavior and the knowledge inside the company instead of just looking to cooperation outside the firm.

5. OPEN ISSUES AND NEW TRENDS

Within the great variety of topics approached when studying the intra-firm coordination and interactions to innovation there are a few themes that shine and are the focus for researchers in several studies. The aspects/topics/themes explored the most are the Knowledge Transfer (21 papers), Networks (13 papers), Technology (12 papers), Social Capital (7 papers) and Communication (4 papers).

- **Knowledge Transfer**

Regarding to the Knowledge transfer, the works of Carayannis (2014), Figueiredo (2013), Liu (2013) are examples on the concerns regarding on how to coordinate the dynamics of intra-firm interactions to enhance the Knowledge transfer in order to generate innovations, new procedures, better performance and value to the firm.

- **Networks**

The work of Jones (2013) discuss the marketing approach in the networks context. The author tries to evaluate how the marketing coordination process can influence the market performance of the firms. Claro (2012), puts his efforts on the evaluation of performance according to the centrality of the network, how this can affect its coordination intra-firm and generation of innovation. The role of networks on the competitiveness is discussed by Alvarez (2009), as Dolfsma (2008) research on how the intra-firm networks are capable to make the knowledge flow and generate innovation.

- **Technology**

Researchers such as Khoja (2008), Giroud (2006), Yoneyama (2004), Malik (2003) and Bailetti (1993) found many evidences regarding the competitiveness, rivalry, intra-firm technology transfer, knowledge capabilities and the coordination problem within the high technology firms. Many of these works suggested relations between knowledge transfer and the competitiveness intra-firm.

- **Others**

Other subjects that have good citations are regarding the intrafirm communication issue, in the work of Aalbers (2015) and Battisti (2009) for instance. In addition, Madlener (2007) argues that the social capital will play a center role in this matter, influencing directly the output of the communication, therefore the knowledge sharing, inside the firm for innovation purposes.

6. CONCLUSION

The recently increase in the number of publications trying to relate, somehow, Innovation, Intra-firm Coordination and Interactions may open new paths for us to understand how the behavior of human beings can influence the creation of value to the firms. The communication aspect seems to be the common ground for most to the papers analyzed. Therefore, the key to success may rely on how the firms manage to provide an environment and the tools for its human assets to develop and to profit of an enhanced communication experience that may enable the knowledge to flow in a way the will end up generating new ideas and moreover innovation.

There are several different approaches emerging around the themes, but the basis for the studies, remain such as Tsai (1998) and Meyer-Krahmer et al (1998). New possibilities as sociological applications and a new psychological, behaviorist point of view are also starting to be explored by the researchers.

The entrepreneurial behavior and the interfirm approaches are most commonly found in studies before 2003, the first period of growing studies, which means that the recent studies treat these approaches as a past trend, searching for new ways to understand the phenomenon. Most recent studies, such as Aalbers (2015) and Laukkanen (2015) highlight that the intrafirm coordination can be understood as a catalyst for the innovative activities inside the firm. The main concern is related for the knowledge leaking risk and this may show us that an important aspect of intrafirm coordination is to retain the knowledge flowing inside the firm and not shared with external actors.

This paper brings a few contributions on the matter of Innovation, Interactions and Intrafirm Coordination. First, showing the growth of the publications related to these subjects in the last few years. This aspect is important mainly because the knowledge transfer within the organization were, as Carlile et al. (2003) pointed out as a “very much black box”. Thus, the new trend may show us that this may change in the next few years, once that there are many new papers and the researchers are starting to look more into the organizations in an attempt to explain the innovation process.

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