

Erasmus University of Rotterdam
School of Economics

Bachelors theses:

"Significance and effects of Michael Polanyi's work
on Economics, as well as other knowledge fields"

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Abstract

In one of my bachelor courses I had Polanyi's paper for discussion and that was the moment of my introduction to the idea of Tacit Knowledge. Generally, most people understand what is Tacit Knowledge or at least can guess what it means, however only a small portion of them really understand the implications and applications that this idea has in real life. I was motivated to find out how significant is this concept of tacit knowledge to economics and many other different knowledge fields. As such, my main research question is: how exactly did Michael Polanyi's concept of "Tacit Knowledge" managed to effect different knowledge fields over a long period of time? In order to do this, I studied Michael Polanyi's Tacit Knowledge and how it was used in later works from different knowledge fields, as well as the implications of those uses. I achieve this by finding papers that are deeply connected to Polanyi's Tacit Knowledge, then read and analyse them. To give a better view of the situation, I also do an analysis on respective knowledge fields, as in how they where effected by Tacit Knowledge. The key aspects that I use, is how often Polanyi's Tacit Knowledge is being cited through time, as well as the papers that use that concept. One of interesting findings of my paper is that tacit knowledge has been cited a lot more often in the recent years, which indicates that its relative significance in general has significantly increased in the last 10 to 15 years. Another interesting finding is that Tacit Knowledge has been incorporated in many ways and some of them are significant in their own respective fields. When presenting those analysis, I find out that not surprisingly Polanyi's breath managed to reach many different knowledge fields, be that in a small and insignificant ways, or having a important impacts on entire respective fields like Business Economics or Computer Since. By combining all those findings I draw a conclusion that Polanyi's work managed to leave an imprint in history of science.

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I. Introduction

In our days, the concept of Tacit knowledge is spread far and wide, with numeral different types of application to it. In my thesis I want to find out how exactly did Michael Polanyi's concept of "Tacit Knowledge" managed to effect different knowledge fields over a long period of time, while putting Economics at its core. This research will provide us with insight into workings of knowledge spillovers, showing how one single article ("Tacit Knowing" page 1-25 of Polanyi's book - " The Tacit Dimension " , 1966) affects opinions of others and in what way does it trigger further innovations within theoretical studies across substantial period of time. I intend trace and analyze papers within many different knowledge fields, which where effected by Polanyi's work. To be more prices, I am going to follow the links between the citations, in order to draw upon statistical data from those works. Afterwards, coming to the main part of my thesis, I will be combining many different papers in an orderly manner to show how exactly did Polanyi's "Tacit Knowledge" effected them and how broad was the spectrum of his influence. By separately reviewing several Polanyi's key followers in depth, I will show how relevant are their papers and how they are connected to Polanyi. With that I hope to be able to prove that Polanyi's breath indeed did manage to reach many knowledge fields and leave it's imprint on them. I believe that finding out to what extant did Polanyi's influence reach all knowledge fields is relevant, as his influence has been steadily growing in the last decade.

II. Polanyi and Tacit Knowledge

Michael Polanyi was born on March 11, year 1891 and died on February 22, 1976. He was born in Vienna, as the fourth child in his family. His father was an entrepreneur and his older brother was a political economist, so it should be fair to say that he comes from a family of Business Economists. However his life took him in a different direction, he was a man of many talents and made many significant contributions to physical chemistry, economics, and theoretical knowledge. His education he obtained from Budapest teacher-training secondary school where he trained as a physician and got his diploma in 1914. With support of Ignac Pfeifer he obtained a scholarship to study chemistry in the Austro-Hungarian army as a medical officer, where he was sent to Serbian front. During his sick-leave in 1916 he wrote his PhD thesis and in 1919 he was awarded with his doctorate from University of Budapest. In process of his life he has occupied many important positions: chair of physical chemistry at Manchester University, then a chair was created for him in Social Science and in 1944 he was elected as a member of Royal Society, as well as elected as a Foreign Honorary Member of American Academy of Arts and Sciences in 1962.

As I have already mentioned his contributions where far and wide, his scientific interests where extremely diverse: chemical kinetics, x-ray diffraction, absorption of gases at solid surfaces. A specific example would be that

he in 1921 laid the mathematical foundation to fiber diffraction analysis and many other significant contributions in philosophy of science.

Out of many contribution that Polanyi made, what really interests us is his contribution to the theory of knowledge . Polanyi expressed his serious opposition to a positivist account of science. He believed that *"people know more than they can tell"*. He rejected the idea that experience can be reduced in to sense data, backing up his position by the idea that our experience is interpreted and our interpretations mostly are acquired through practice. He makes an example that an apprentice acquires his non-explicit knowledge by observing the master or doing it himself.

The very first time Polanyi introduced concept of Tacit Knowledge was in his book "Personal Knowledge" (1958). He saw his finding of "structure of tacit knowing" as his most important discovery. In his later work " The Tacit Dimension " (1966), he seeks to distinguish between the different aspects of tacit knowing.

If I had to give clear answer to what does Polanyi mean by "tacit knowledge", It would be that there is a type of knowledge that is not captured by language or mathematics. As such we can only observe it though actions. Tacit knowledge is knowledge that the actor knows he has (how to hit a ball, put cloths on, or doing cleaning around the house) yet he cannot, explain in terms other than its own performance: *"the aim of a skilful performance is achieved by the observance of a set of rules which are not known as such to the person following them"* (Polanyi - "Personal Knowledge", 1958, page 49). The "a set of rules" may sounds strange to us here and so Polanyi explains:

"Rules of art can be useful, but they do not determine the practice of an art; they are maxims which can serve as a guide to the art only if they can be integrated into the practical knowledge of the art. They cannot replace this knowledge." (Michael Polanyi, Personal Knowledge, 1958 page 50)

To sum it up, tacit knowledge is knowledge we have, and know we have, but nonetheless we cannot put into words. Following such comments, Polanyi seems to be inserting the tacit as a category outside language.

In order to be objective on this topic, I will introduce some critic from Jerry Fodor. In his view, Polanyi's distinction seems to be very obvious to Fodor, to a point that he considered it to be very surprising, if no one else had made it. Fodor referred to Gilbert Ryle's - "The concept of Mind " (1949), where distinction between knowing that something was the case, and knowing how to do something is made. Gilbert called this distinction "knowing that" and "knowing how". With this classification Fodor believes Polanyi's concepts become very obvious and if stretched could be even called trivial.

As there are those that criticize Polanyi, there are those that consider his work to be important as well. One of those people is Mark T. Mitchell, he wrote a book: "Michael Polanyi: The Art of Knowing, promises to attract more readers to an important thinker" (2006). In his book he introduces readers to Polanyi's work's and a significant part of it is on his idea of Tacit knowledge. At the ending of his book, this is what he says about Polanyi:

"Polanyi points a way out of the dark forest of rational skepticism and systematic doubt. He shows us how we might once again speak meaningfully of good, the true and the beautiful. And he shows us how we might recover an understanding of the importance of the places we inhabit and the persons with whom we live." (Michael Polanyi: The Art of Knowing, 2006, p. 169)

III. Methodology

In this part of my thesis I will explain the tools and some terminology that I will use in order to help me analyse the papers and knowledge fields, effects and relationships between them. To do so I will use an already existing database that allows for such a form of research, the name of it is "Web of Knowledge". It is a large database of many papers from different fields of study. It also holds many tools and is divided in a few specialized databases. The one that I am going to use is "Web of Science", as it provides most tools that are necessary for my research. By making use of those tools I will be able to find out much of important information, like which countries cited Polanyi's work most, or find the progression of those citations through the long period of time.

Some of the simpler tools, gather the years of publication, subject areas, regions / countries of publication, the % margins and many others, however some require more explanation. The explanations to these analysis might be required at a point in: " IV. Overall Analysis ":

The most basic tool that allows me to find the correct papers in the entire database is the: search tool. It is special because it can account for many factors by means of filtering and can be performed on any selected list of papers, be that personally selected one, or the ones found in the previous search. By proper combination and inclusion of different aspects of filtering & analytical aspects(years, subject area, countries and others), many outcomes can be found. For example. I will want to find how one subject area, is also related to other subject areas. I will find this by selecting the entire paper list (papers connected to the book "The Tacit Dimension") and will do filtering based on subject first, in order to choose the desired subject area. After choosing a subject area(in my paper I used the "Business Economics"). I repeat that process one more time, to see under what other subject areas are these papers also listed (Very often papers are included in a few subject areas when they are stored in the "Web of Science"). Similar combinations are used to perform other analysis as well. As I am done with my analysis I can make use of tools that organize the findings in to tables and graphs, however some of them require further analysis in Excel.

Another important fact to note, is that all of the used data has been gathered on the 17-18 of July 2011. As such all the relevant calculations, numbers and percentages should be considered to be reported on that date.

In addition , there will be some authors that I will call - Polanyi's key followers. In order to be classified as Polanyi's key follower, papers written by those authors have to be highly cited and pass my connection check. This connection check is a thorough check on whether the papers themselves mention or cite Polanyi in such a way, that It can be subjectively considered that Polanyi made an impact on the key followers ideas.

IV. Overall Analysis.

Now that we have a good idea of what tacit knowledge is, we should take a closer look at how I am going to back up my research with organized findings and supportive data. For starters let me explain the core of the scientific approach that I have used here:

The goal of this paper is to show the importance of Polanyi's work in Economics and other knowledge fields. I intend do this through the use of citation analysis, which means that most of the supportive information will be of analytical nature. To achieve this I will have to trace the impact of Polanyi's idea of Tacit Knowledge on economics, as well as many other knowledge fields, by following the citation patterns through historical data. I will be using the tools from the "Web of Science" database to do my analysis. By doing series of analysis on "Tacit knowledge" of the Michael Polanyi's book "The Tacit Dimension", I aim to find proof that is significant enough to support my claim of Polanyi leaving a meaningful mark in many different knowledge fields.

4.1 First step is to show the importance of Polanyi's work for economics, as such I have to provide some solid statistical data to make such a claim relevant. Thus, I have made use of some tools, in order to be able to organize historical data in the database. More specifically, I have found most of the papers that cited Polanyi's idea of "Tacit Knowledge" and converted them in to numerical findings against time. More specifically I take Polanyi's book "The Tacit Dimension" (1966), as it holds greatest relation to his idea of Tacit Knowledge. By doings so, I managed to find out how often did Polanyi got cited for each specific year and made a graph of this relation (Table 1 & 2).

Table 1, Shows number of publications that cited Polanyi for years 1978-2011

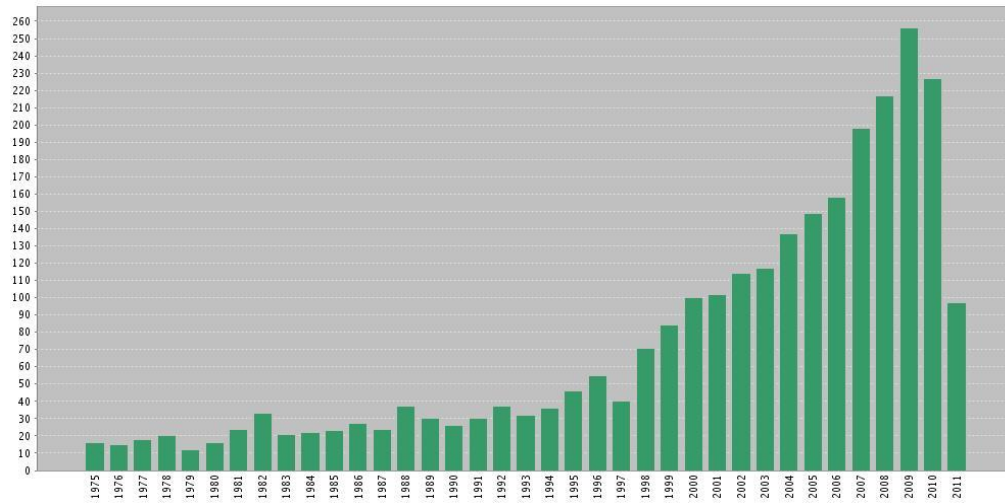
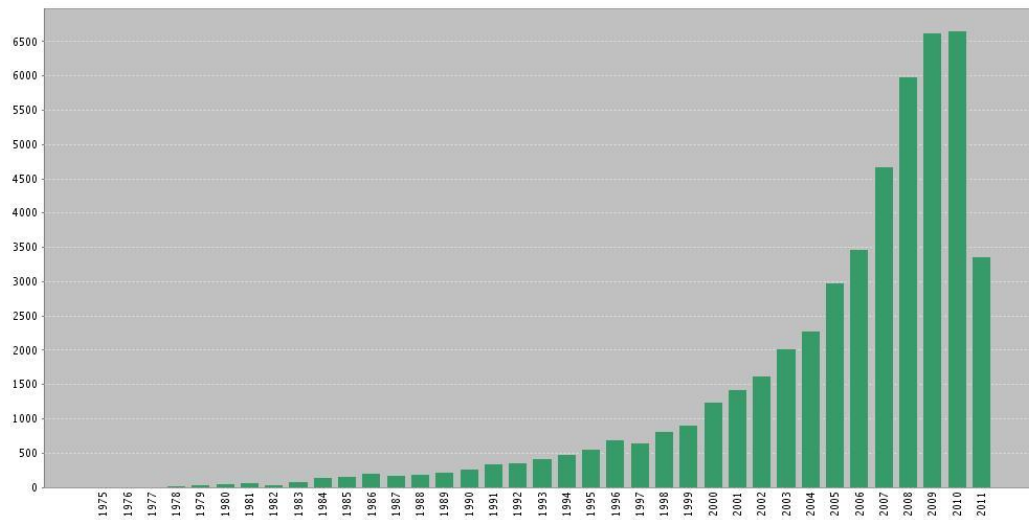


Table 2, Shows number of Total citations on Polanyi for years 1978-2011



From the two tables above we can see that the number of publications that cited Polanyi have been steadily yet very slowly increasing from years 1975 till 1995. The same situation can be observed for the actual count of citations in that period of time, however in 1996 something changed and number of both publications that cited Polanyi as well as the number of actual citations sky rocked and the rate of increase of citations have gone further up from one year to another (Table 3).

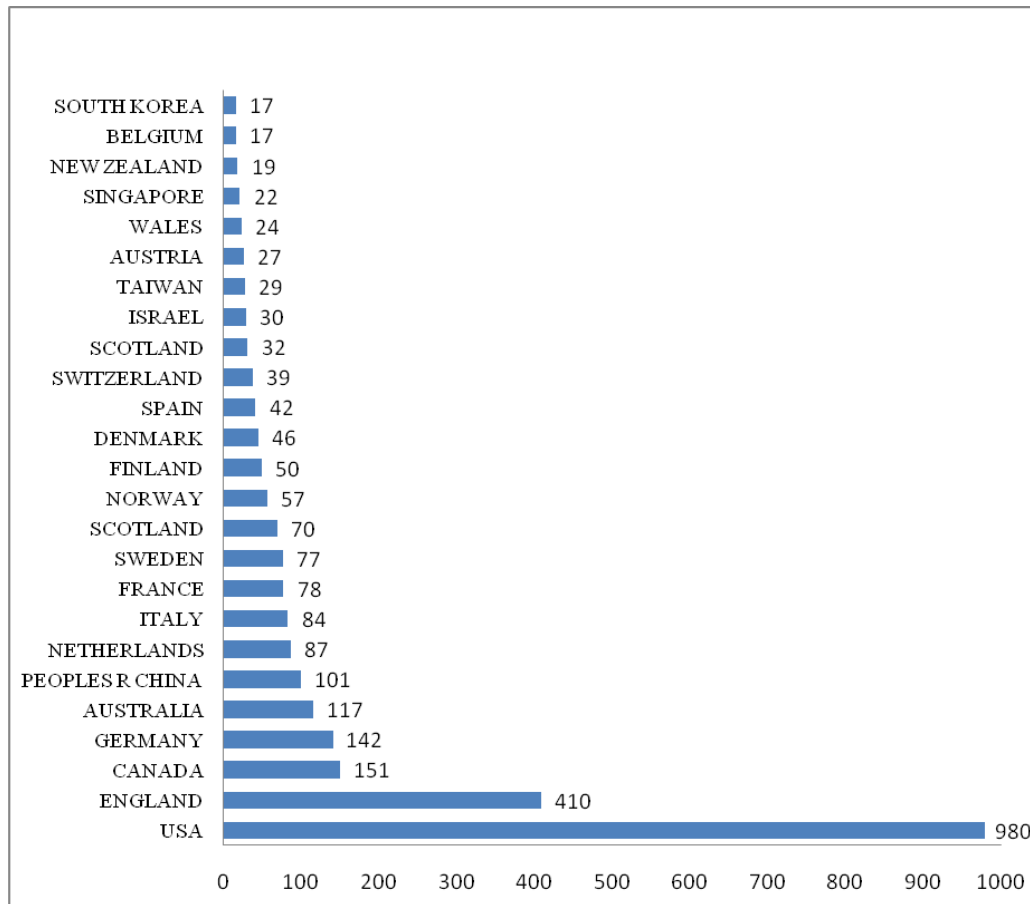
Table 3, Shows the count and % margin. 1979-1974 - at the beginning; 1995-1999 - first substantial increase; 2006- 2010 present rate of increase; With years growth rate is observable.

Field: Publication Years	Record Count	% of 2667	Bar Chart
2009	256	9.599 %	■
2008	217	8.136 %	■
2007	198	7.424 %	■
2006	158	5.924 %	■
------(not much change in the rate of growth)-----			
1999	84	3.150 %	■
1998	71	2.662 %	■
1996	55	2.062 %	■
1995	46	1.725 %	■
------(not much change in the rate of growth)-----			
1975	16	0.600 %	
1980	16	0.600 %	
1976	15	0.562 %	
1979	12	0.450 %	

By analyzing the Table above we can come to a conclusion that the % margin (number of publications in that year divided by the total number) of publications with citation indeed started to rapidly grow starting from 1996, by approximately 0.5% per year in contrast of 0.05% in 1980's. As such we have found more grounds to base my initial statement of Polanyi's work being significant. On that note I want to point out that the 50% drop in citations in Tables 1 & 2 in year 2011, is not because of the actual decrease of citations, rather it is because the year 2011 is only half way through and there is a time lag in the system that should be accounted for as well. In addition Table 3 shows only the most vital years of change to make the picture more comprehensive.

In order to add some understanding about the regional spread of Polanyi's idea of Tacit Knowledge. I have also performed a regional analysis, showing which courtiers experienced the most influence of Michael Polanyi work (Table 4.1).

Table 4.1, Citation count for each country - for Polanyi's work



From the Table above we can see that an overwhelming amount of publications is being cited in USA. From just this information we cannot make a clear deduction, if 980 cited publication counts for USA is high or not. In order to find out, I introduce another paper and do the same analysis on it. The name of the paper is "Upper Echelons: The organization as a Reflection of its Top Managers" - (1984), written by Donald Hambrick and Phyllis Mason. This paper was chosen, because it has very little connection to Michael Polanyi and yet still has a significant impact on the main knowledge field "Business Economics".

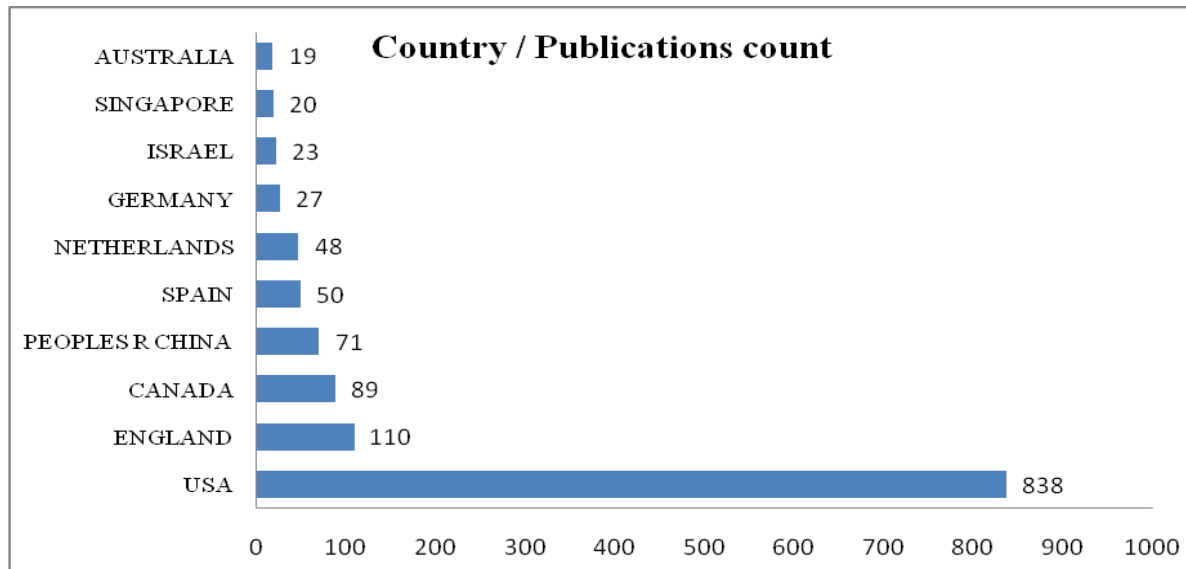
This paper tries to answer a very important question: "Why do organizations act as they do?". In it, the authors argue for an emphasis on dominant coalition of the organization, in particular its top managers. Show how the organizational outcomes, both strategies and effectiveness, could be perceived as the reflections of values and cognitive bases of powerful people in the organization. The authors themselves say this:

"Theorists in various fields have discussed characteristics of top managers. This paper attempts to synthesize these previously fragmented literatures around a more general "upper echelons perspective." The theory states that organizational outcomes-strategic choices and performance levels-are partially predicted by managerial

background characteristics. Propositions and methodological suggestions are included." (The Academy of Management Review, 1984, page 193)

This paper by itself should be a good reference to see how important is Polanyi's work. As such I do the same regional analysis for Hambrick's and Mason's paper (Table 4.2):

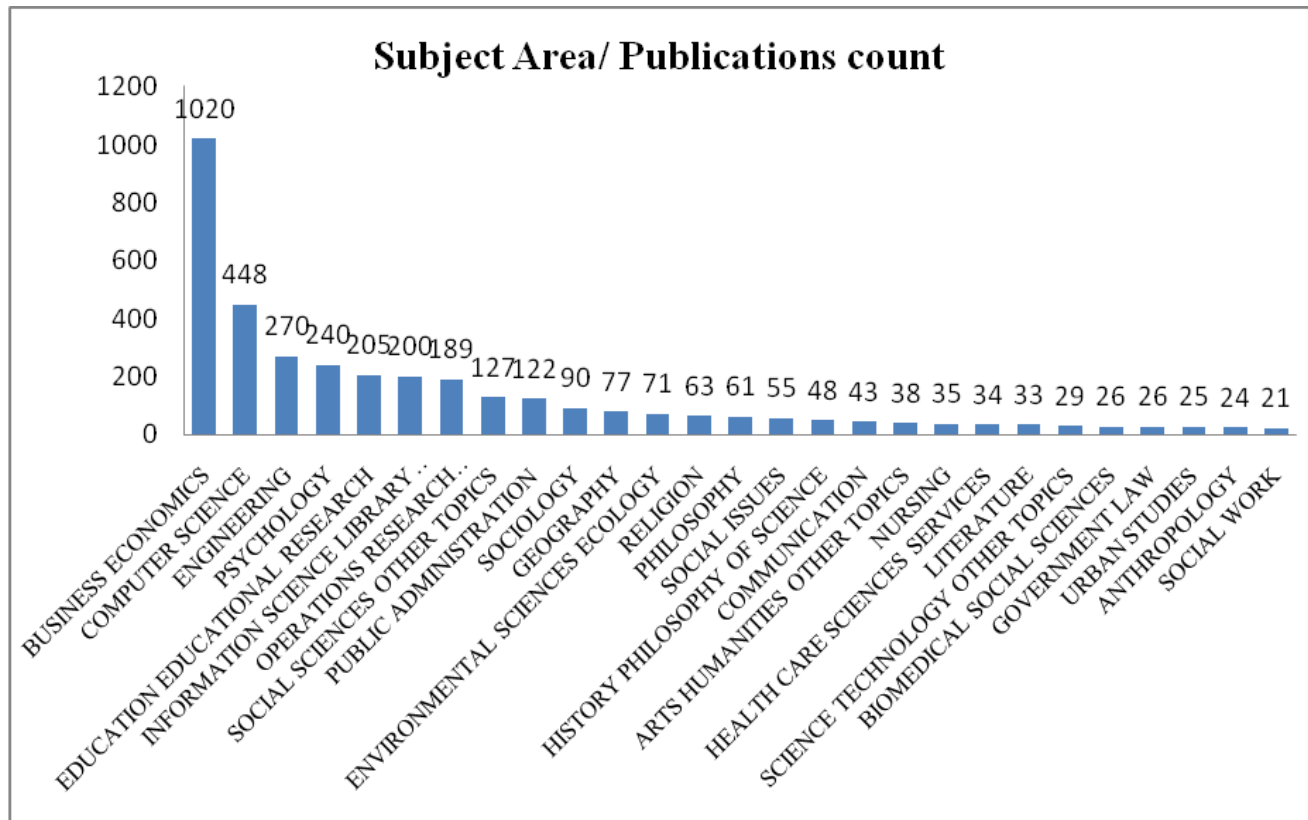
Table 4.2 , Citation count for each country - for Hambrick's and Mason's work.



The table above clearly shows us that USA plays a significant role in publication count of Hambrick's and Mason's paper. From comparison of Table's 4.1 and 4.2 we can come to a conclusion that having an overwhelming amount of publication counts in USA, is a normal occurrence. I believe this finding can be contributed to the fact that USA is rather a big country and has a lot more of researches and different kinds of institutions in it, in relative comparison to other countries. For Polanyi this means that the high citation count in USA is not all that high, rather it is average.

4.2 After doing the basic analysis on Michael Polanyi's work, I follow it up with the second step. In the first step I tried to demonstrate the general importance of Tacit knowledge and in the second step, I am going to differentiate between the effects on different knowledge fields. To do so I once again perform a series of citation analysis, however this time I sort the publications with citations in different subject area groups (Table 5.1).

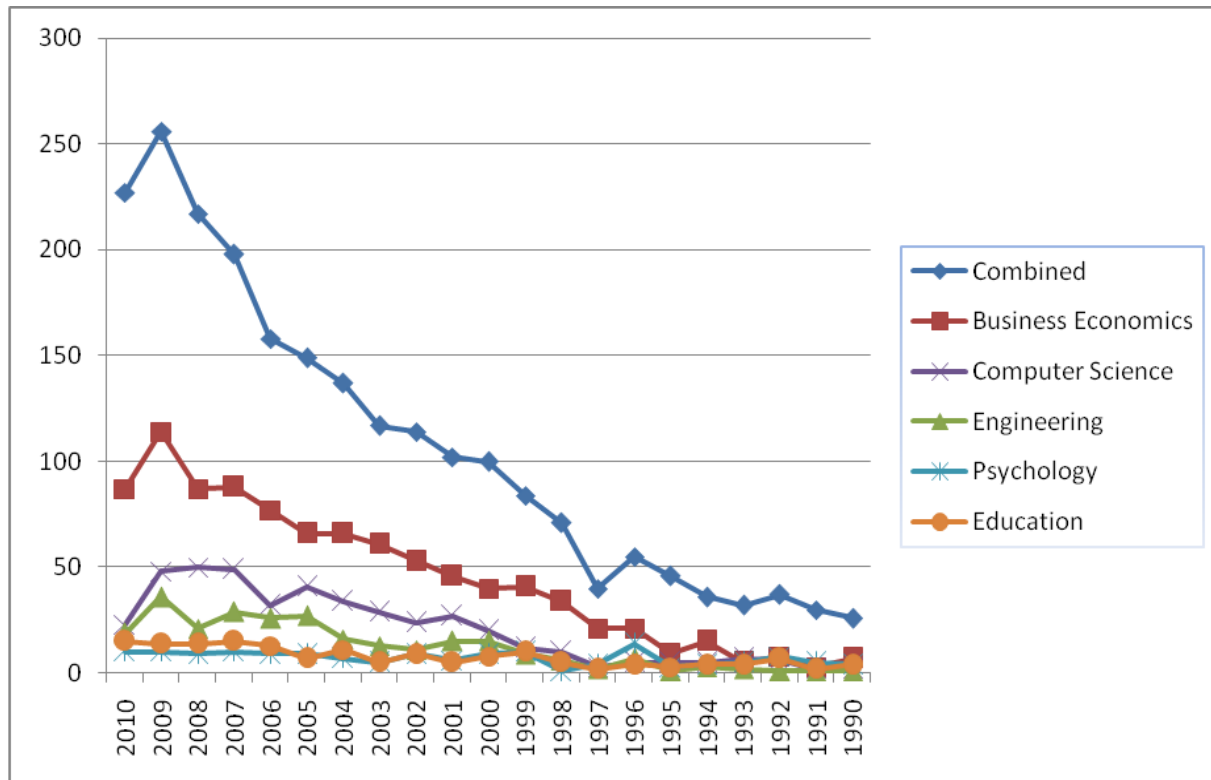
Table 5.1, Number of citations attributed to each specific Subject Area



From the table above we can see that a significant 38.2% portion of all accounted publications can be contributed to Business Economics, this by itself should be proof enough to show that Polanyi's work did manage to leave a great impact on knowledge field of Economics. In addition to that we can clearly see that the impact on fields after "Operations research" is relatively smaller to the first several knowledge fields, so for now I will leave the least relevant ones alone and concentrate on the main fields. More specifically, I will concentrate on the top five of them, as they are the ones effected the most: Business Economics, Computer Science, Engineering, Psychology and Educational Research. Once again I have to note that the categories that I have chosen in Table 5.1, where specifically designated within the "Web of Science" system. Even though the where more diversified options, I decided to choose this type of classification as it provides more specialized results(for example, in other options "Business Economics" would have been divided in to "Management" and "Business" as two separate categories).

However, before we look at all of them separately, in Table 5.2 I present a table that shows the cited publication counts for all five most significant categories in last 20 years.

Table 5.2. Cited publication count for last 20 years, for 5 knowledge fields and a combination of all of effected knowledge fields.

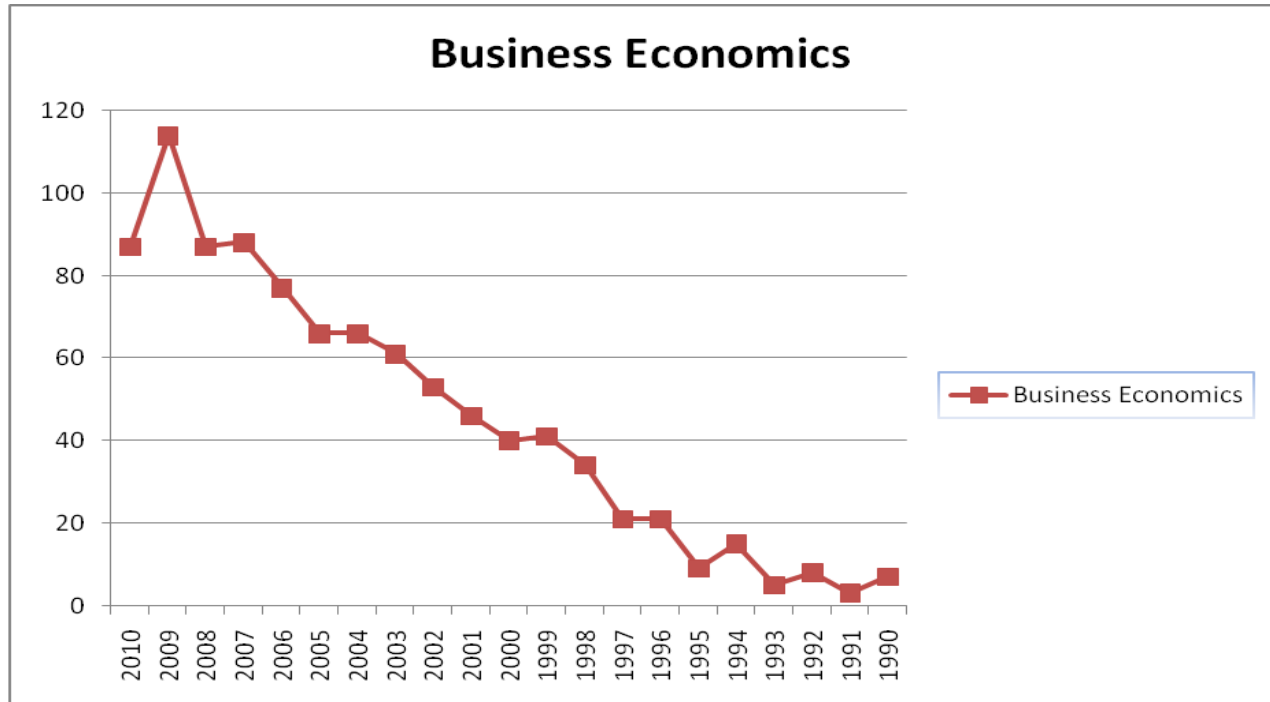


From the Table above we notice a few important points. The first one is that the knowledge fields: Business Economics and Computer Science are a lot more significant than all other fields. In addition, the first to fifth most important fields are almost the same in number of citation counts. The second point of interest is how the number of citations grow over time. Also on that account the citation count decline in the years 2010-2009 could be attributed to the "Web of Science" time lag in accounting for the newest papers that are not yet in the system.

Now that we managed to isolate different knowledgeable fields from each other, we can make more specialized analysis, which should provide us with more data to take in for consideration. As already mentioned, I picked out five most significant areas under Polanyi's effect and do the same analysis that I have done before to determine general significance of Tacit knowledge by taking in account the new factors.

4.2.1 The first one that I am going to examine is Business Economics, thus I will analyze the works that cited Polanyi's "The Tacit Dimension" and only those that are with the subject area of "Business Economics". To perform the first analysis I take the year to cited publication count (Table 6):

Table 6, Relation between the publication years and their cited publication counts



From the Table above we can see that the "Business Economics" subject area follows the a pattern where number of citations start to increase substantially after 1996. Though this can be explained by the fact that more than 38% (1020- within "BE" field/ 2667 - Total) of all cited publications belong to this knowledge field. This findings give a relative idea how great of impact did this knowledge field experience from Polanyi's work, in comparison to other fields. Whether this pattern can be called a trend or not is not yet clear, however we can get closer to confirming it by examining the following findings (Table 7.1 & 7.2)

Table 7.1 Shows number of publications that cited Polanyi with in "Business Economics " for years 1978-2011

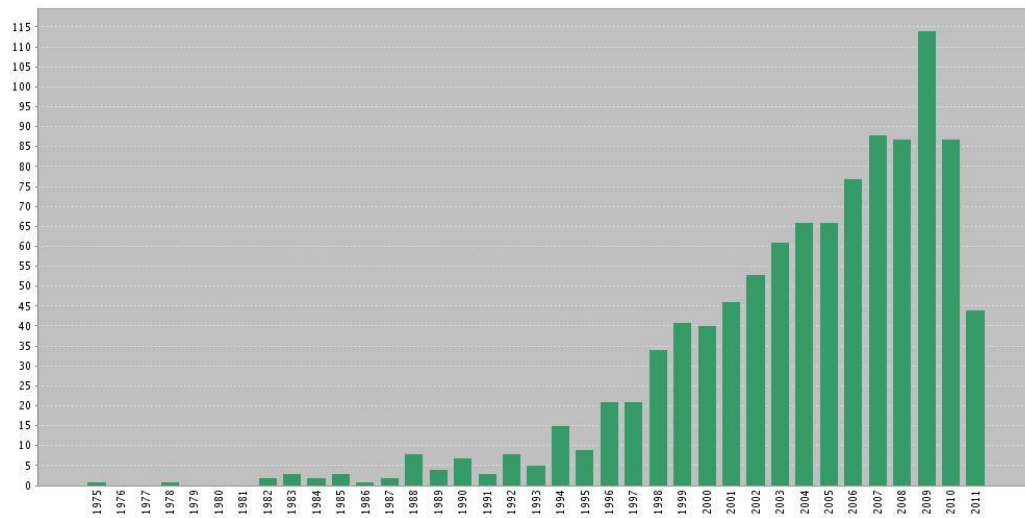
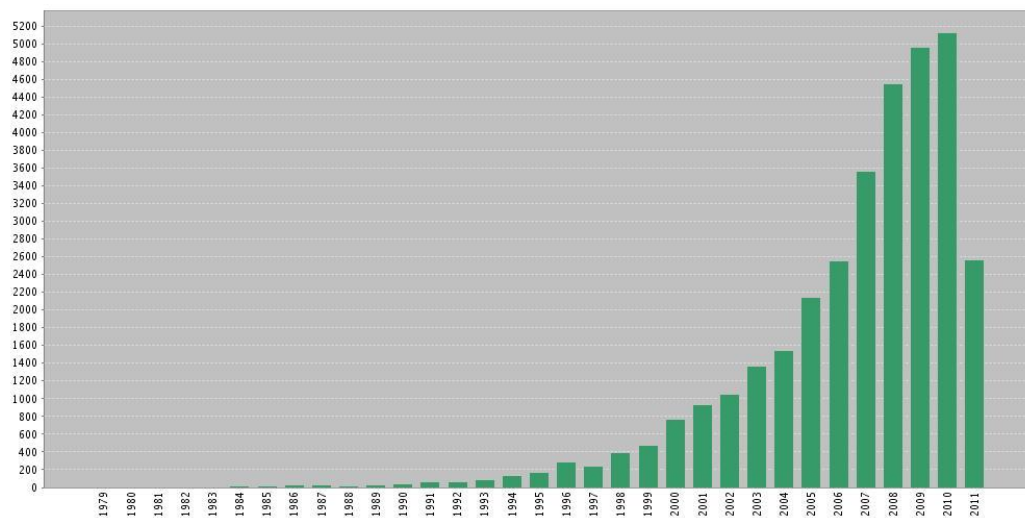


Table 7.2 Shows number of Total citations on Polanyi with in "Business Economics " for years 1978-2011



If we carefully examine the Table 7.2 and compare it to Table 2, as well as Table 7.1 to Table 1, we will find that the highest yearly ratio of actual citations that is contributed to "Business Economics" is more than 83% ($5200 - \# \text{ of citations in "BE"} / 6200 - \text{Total \# of citations for all knowledge fields}$), while the number of publications ratio is below 45% ($115 - \# \text{ of cited publications for "BE"} / 260 - \# \text{ of cited publications for all knowledge fields}$) - this ratios were calculated for the year 2010. This findings are of great importance, as they show that most of the impact that Polanyi's work had causes, should be attributed "Business Economics" specifically - even though only 45% of publications were attributed to "BE", this knowledge field has more than 83% of citations (number of citations show how widely accepted a paper is).

In order to further demonstrate the existence of the trend I present a few other results, from different other analysis (Table 8.1 & 8.2).

Table 8.1 Publications with citation to Polanyi's work with in "Business Economics"

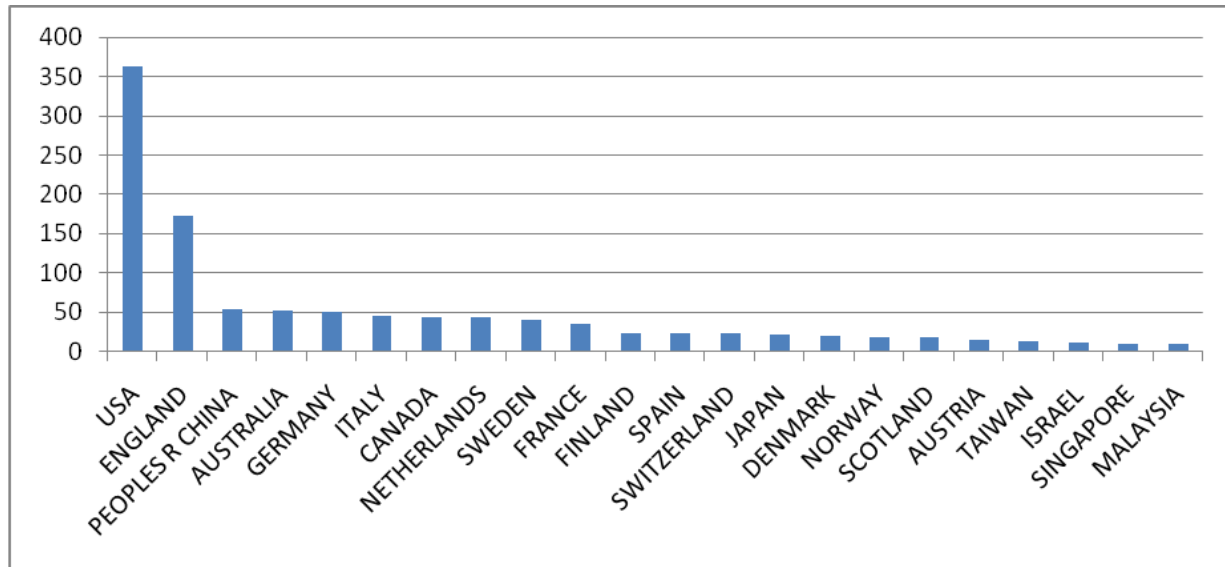


Table 8.2 Relation of publications with citation to Polanyi's work with in "Business Economics" to other knowledge fields

Field: Subject Areas	Record Count	% of 1020	Bar Chart
BUSINESS ECONOMICS	1020	100.000 %	<div style="width: 100%; height: 10px; background-color: #4F81BD;"></div>
OPERATIONS RESEARCH MANAGEMENT SCIENCE	135	13.235 %	<div style="width: 13.235%; height: 10px; background-color: #4F81BD;"></div>
ENGINEERING	118	11.569 %	<div style="width: 11.569%; height: 10px; background-color: #4F81BD;"></div>
INFORMATION SCIENCE LIBRARY SCIENCE	98	9.608 %	<div style="width: 9.608%; height: 10px; background-color: #4F81BD;"></div>
COMPUTER SCIENCE	90	8.824 %	<div style="width: 8.824%; height: 10px; background-color: #4F81BD;"></div>
PUBLIC ADMINISTRATION	70	6.863 %	<div style="width: 6.863%; height: 10px; background-color: #4F81BD;"></div>

By looking at the Table 8.1 we can see that the trend is present, meaning that most publications that fit the criteria are made in USA. As such it should give us some idea about the question of whether this findings are biased or not. In addition I have run an analysis, on whether the works that are categorized to be with "Business Economics" field are also related to other subject areas. I accomplish this by utilizing one of the "Web of Science" tools. The results in Table 8.2 should be of no great surprise, as most papers and research touch other areas of expertise in one way or another.

4.2.2 This thesis main goal is to show how does Michael Polanyi's concept of "Tacit Knowledge" effects Economics and other knowledge fields. The number of effected knowledge fields are too many to be explained in a bachelor thesis, thus additional four most important subject areas are included in the main analysis: Computer Science, Engineering, Psychology and Educational Research.

To see how exactly these four knowledge fields where affected, I have done separate analysis on all of them. The analysis where the same ones that I have done for the "Business Economics". Presenting findings for all of them will be too lengthy and serve little purpose, as they are mostly the same, in numerical value, as such I will summarize them.

After completing the analysis on those four subject areas, the results provided a very similar numerical result (naturally in relation to their initial size, for example if growth rate for "Business Economics" was 38% with the sample size of 1020, the growth rate for "Computer Science" is approximately 38 % as well with the sample size of 448). As such, same trends could be observed in all four of them, meaning the sudden rapid growth rate in number of citations, as well as in cited publications, started to appear after the middle 90's (observed in Table 5.1 and 5.2). Also for all those knowledge fields the most significant amount of contributions have been made from USA, though in this case the percentage varied. However, this variance was not exactly disruptive, it strengthened the initial findings of USA being the center of generating most of citations in all knowledge fields.

V. A report on the in depth reading of some key followers

Now that we have grasped the importance Michael Polanyi's work in both general meaning as well, as in many different subject areas separately, we can concentrate on the subject areas themselves and find the specific contributions to each one of them, the idea of Tacit Knowledge has made.

To do so I have selected a few works from five main subject areas that have the highest number of citations. Having a high citation rate means that those works have been found of some importance to others, hence to a degree they managed to contribute to their respective subject areas, I call them Polanyi's key followers. After selecting those few key followers, I carefully read those papers and try to find out how exactly did Tacit Knowledge influenced them. We will begin by taking a few most important works with in "Business Economics" subject area and explaining what they are about and how does Tacit Knowledge fit in them.

5.1.1 The first work that earned 1848 citations was written by Ikujiro Nonaka "A Dynamic theory of organizational knowledge creation", published in 1994. His paper gave an almost revolutionary view on managing the dynamic aspects of organizational knowledge creating processes, by focusing on the idea that Knowledge within an organization is created through a continues dialogue between tacit and explicit knowledge, more explanation a bit later. As he proposes his paradigm, he shows that this dialogue consist of four major patters of interaction. He argues that even though new knowledge is mainly developed by individuals, organizations have a vital role in articulating and amplifying that knowledge. Polanyi's concept of "Tacit Knowledge" played a vital role in Nonaka's approach:

"In Polanyi's words, tacit knowledge "dwells" in a comprehensive cognizance of the human mind and body. While Polanyi articulates the contents of tacit knowledge in a philosophical context, it is also possible to expand his idea in a more practical direction. Tacit knowledge involves both cognitive and technical elements. ... " (Ikujiro Nonaka, 1994, page. 16)

By taking Polanyi's philosophical view on tacit knowledge, Nonaka developed theoretical framework which provides an analytical perspective on the constituent dimensions of knowledge creation and later made a model for knowledge creation within firms.

The most important part that Tacit knowledge plays in Nonaka's work is when he defines the four modes of Knowledge Conversion (Table 9):

Table 9, Four Modes of Knowledge Conversion (Figure 1, modes of knowledge creation - Ikujiro Nonaka: Dynamic Theory of Organizational Knowledge Creation, 1994 - page 19)

		Tacit knowledge	To	Explicit knowledge
From	Tacit knowledge	Socialization		Externalization
	Explicit knowledge	Internalization		Combination

First is a mode of knowledge conversion that enables us to convert tacit knowledge through integration between individuals. An important point is that individuals can gain tacit knowledge without the use of language: *"Apprentices work with their mentors and learn craftsmanship not through language but by observation, imitation, and practice. In a business setting, on-the-job training (OJT) uses the same principle."* (Ikujiro Nonaka , 1994, page. 19)

The core of gaining tacit knowledge is experience and the process of sharing experiences in order to acquire tacit knowledge is called by Nonaka "**Socialization**".

Second mode of knowledge conversion makes use of social processes to combine different bodies of explicit knowledge that is held by individuals:

"Individuals exchange and combine knowledge through such exchange mechanisms as meetings and telephone conversations. The reconfiguring of existing information through the sorting, adding, recategorizing, and recontextualizing of explicit knowledge can lead to new knowledge." (Ikujiro Nonaka, 1994, page. 19)

Nonaka called this process of creating explicit knowledge from explicit knowledge as "**Combination**".

Third and fourth modes of knowledge conversion refers to the patters of conversion between both tacit and explicit knowledge. This mode captures the idea that tacit and explicit knowledge are indeed complementary and by process of mutual integration can expand over time. I should note that this contradicts Polanyi's idea of Tacit Knowledge.

*" Interaction involves two different operations. One is the conversion of tacit knowledge into explicit knowledge, which will be called "**externalization**". The other is the conversion of explicit knowledge into tacit*

knowledge, which bears some similarity to the traditional notion of "learning" and will be referred to here as "internalization". " (Ikujiro Nonaka, 1994, page. 19)

However, Nonaka's theories of organizational learning have no mention of a very important notion of externalization, and have given very little attention to the importance of socialization. Other problematic aspect is the concept of "double loop learning" (Argyris and Schon, 1978), or "unlearning" (Hedberg, 1981), which comes from a strong orientation toward organizational development.

5.1.2 The next paper that I going to discuss has 1806 citations and was written by is Bruce Kogut's and Udo Zander's - "Knowledge of the firm, combinative capabilities, and the replication of technology", published in 1992. In their work, they identify a paradox: that efforts by firms to grow through replication of their technologies gives rise to the potential for imitation by compaction (This can be illustrated well in cases of Operational Systems on computers, if the base code for the new OS is similar to the old ones, it is easier for the competitors to imitate it). In contrast to that, the authors demonstrate how imitation can be deterred by innovation, as such from this two points they come to a more dynamic view of how firms create new knowledge. The main message of their paper is that they suggest to firms to learn new skills by recombining their current capabilities (for example instead of hiring expensive new experts, it would be more efficient to combine experts from different departments in a new research group). Brining such arguments as that new cooperation channels cannot be easily acquired, or that that growth accure by building on the social relationships that currently exist in a firm, not by seeking new completely unknown opportunities. Taking that idea further, they show how the firms future possibilities tend to lay with in what they have already done in past. This way, the cumulative knowledge of the firm provides options to expand in new, yet uncertain markets in the future without any need for acquiring new specialist. As such authors say the following:

"This article seeks to lay out an organizational foundation to a theory of the firm. To rephrase Polanyi's puzzle of tacit knowledge, organizations know more than what their contracts can say. The analysis of what organizations are should be grounded in the understanding of what they know how to do. ... " (Bruce Kogut's and Udo Zander's, 1992, page 383)

This paper demonstrates how tacit knowledge can be not just applied to a singular person, but an entire firm as a whole. The concept of Tacit knowledge is used in this paper to raise the questions how it is best to use internal knowledge and what incentives would induce behavior that would benefit the welfare of the organization. All findings and conclusions point out that at 1992 there was a need to investigate what organizations do wrong in more detail:

"After nearly two decades of research in organizational and market failure, it is time to investigate what organizations do." (Bruce Kogut's and Udo Zander's, 1992, page 396)

5.1.3 The third and the last example that I chosen from "Business Economics" subject area has 1565 citations and was written by Robert M. Grant - "Toward a knowledge-based theory of the firm", published in 1996. The main contribution of Grants paper is in exploring the coordination mechanisms through which firms integrate the specialized knowledge of their members. The author demonstrates how unlike in the earlier literature, knowledge is viewed as residing within the individual, while having the primary role of the organization is not knowledge creating, rather knowledge application (a good example of the "earlier paper" would be 5.1.1 - Nonaka, 1994, he sees knowledge creation as the core of knowledge in the firm). This approach to knowledge within organizations resulted in theory that has implications for the basis or organizational capability, fundamentally questioning the basic organizational design and management practice. There are many aspects of his analysis, that are of importance, however the one that interests us is the transferability of knowledge. He defines many ways and reasons for the transfer of knowledge and here lies the root of tacit knowledge in this paper:

" The management literature has clearly recognized the epistemological distinction between knowing how and knowing about which is captured by distinctions between subjective vs. objective knowledge, personal vs. propositional knowledge, and procedural vs. declarative knowledge. My purpose here is not to make fine distinctions between different types of knowledge. I identify knowing how with tacit knowledge, and knowing about facts and theories with explicit knowledge. The critical distinction between the two lies in transferability and the mechanisms for transfer across individuals, across space, and across time. ..." (Robert M. Grant , 1996, page 111)

While attributing tacit knowledge to knowing how and explicit knowledge to knowing about, he presents demonstrations and examples of how knowledge is best utilized and transferred between individuals, within a firm.

Grant paper attempts to counter balance the Nonaka's (1994) and other earlier literature on knowledge creation and organizational knowledge by concentrating on knowledge application and the role of individuals instead. By making the role of the individual as the main actor in the knowledge creation, Grant hopes to show how important it is for clarifying the role of organizations in the creation and application of knowledge. However, if knowledge creation is disregarded, he is faced with the fact that focusing on knowledge application is a great limitation. As such coming to a conclusion that knowledge-based theory of the firm should comprise of both knowledge creation and application.

5.2.1 Now that we have a good idea about the key followers in the core subject that is related to Tacit knowledge - "Business Economics". We can go to the second most effected by Polanyi's ideas subject: "Computer Science".

The first Key follower that I am going to present is "Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues", published in 2001, written by Maryam Alayi and Leidner, DE and their work has been cited 857 times.

In this paper authors present a review and interpretation of knowledge management literature in different fields with an eye aimed at identifying the vital areas for research (examples: Cole 1998; Spender 1996a, 1996b; Nonaka and Takeuchi 1995 and others). They provide detailed process of how to examine organizational knowledge management, with focus on potential role of information technology in this process. Mainly basing their research on literature reviews and analysis of knowledge management systems. Obviously as it was already stated in the paper of the very first key follower (Nonaka, 1994), proper management requires knowledge creation that is heavily connected to Tacit knowledge and this leads authors of this paper to conclude that:

"The inextricable linkage of tacit and explicit knowledge suggests that only individuals with a requisite level of shared knowledge can truly exchange knowledge: if tacit knowledge is necessary to the understanding of explicit knowledge, then in order for Individual B to understand Individual A's knowledge, there must be some overlap in their underlying knowledge bases." (Maryam Alayi, 2001, page 112)

inextricable - impossible to break

If we compare this idea with how Polanyi defined tacit and explicit knowledge, we will find out that, authors of this paper have a completely opposite opinion about the connection between those two types of knowledge. They believe that connection between tacit and explicit knowledge to be mutually dependent and in such a way that it is impossible to break the connection between them.

5.2.2 The next paper has 147 citations and written by Michael Earl - "Knowledge management strategies: toward a taxonomy", published in 2001. The main purpose of authors research is to propose a taxonomy of strategies, or "schools" for knowledge management. His intention where to make a framework that will guide executives, when deciding on choices, in such a way that it would stimulate knowledge management projects according to goals, organizational character, and technological behavior. He also believes that his research will be beneficial to teachers to show the scope of knowledge management, as well as to researchers in generating propositions for future studies.

The direction that he chooses to reach his goal goes through Informational Technologies. As he provides many examples of how Informational technologies can be utilized for knowledge management, he encourages further use of available tools (technology) to maximize the management capabilities. If we compare his idea of relation between tacit and explicit knowledge to other authors and Polanyi himself, then we will see that he follows the most common scientific view that explicit knowledge provides more possibilities of use and is more relevant in technological societies. In one of his examples he talks about a head office of British Airways at Waterside near Heathrow Airport. It is designed in a way that encourages communication and teamwork. The special part of that office is that the ground floor is made in a medieval street fashion. This layout forces people to navigate the building by making them keep walking down or crossing the street. The sides of the street themselves hold many shops of different kind, which means that there are many different kinds of people walking all around. This is what he says about this layout:

"In other words, a medieval street is likely to facilitate exchange of both explicit and, more particularly, tacit knowledge. It is also a space where the quick message can be exchanged or a further meeting arranged. The whole building was designed to maximize the number of times you "bump into people." " (Michael Earl, 2001, page 226)

With many similar examples he makes sense of the many corporate initiatives and manages to provide a frame of reference for both scholars and practitioners. Another purpose of his research was to once again demonstrate how important is proper knowledge management (explaining that proper IT applications are necessary to maximize efficiency) to those that consider it to be a matter of fact, while never really give a real consideration to improvements and possibilities of innovation in knowledge management.

5.2.3 The third article in this subject area that I am going to discuss has 123 citations and was written by a group of authors: Terri L. Griffith, John E. Sawyer, Margaret A Neale - "Virtualness and knowledge in teams: Managing the love triangle of organizations, individuals, and information technology", published in (2003).

The main message of their work is that as the informational technologies further develop and become more common in companies, the communications between people face-to-face greatly diminishes, be that because of people not able to meet or simply because they act on their functions in the company and ignore all the rest. Such a situation is mainly caused by the increasing necessity of companies to make more out of less. The two most observed approaches in such situations are to seek synergies by structuring work in to team processes, and to be more efficient in the use of organizational knowledge. As such, a transformation of knowledge from individuals to teams and organizations. When teams working on some project are put in such environment they start to concentrate more on becoming better at both making and using explicit knowledge. This is where the problem starts, in current age we still do not have technologies that can completely replace face-to-face meetings, as a result it is fair to say that technology has its own limitations, companies without realizing it loses much of their tacit knowledge and make

their goal of efficiency even harder to achieve. If we try to compare this papers concept of tacit knowledge to Polanyi's, we will find that they are very similar, except for the fact that authors here put more value in explicit knowledge than Polanyi did, while still holding to belief that tacit knowledge is irreplaceable within organizations. By providing some examples (e.g. Griffith and Neale 2001) authors of this paper manage to show how efficiency is lost, because of lack of exchange in tacit knowledge between and within virtual teams.

As such authors provide rules that should be able, to make sure that the combination of information technology and more virtual work does not cause a change in the dynamics of knowledge transfer in organizations in unintended ways:

"-Verbalization of rules, terminology, and descriptions

- experience-building opportunities with team members, technology, and tasks.

- access to tools that support highly interdependent work.

- development of communities of practice.

- development of strategies and technologies that support transitive memory.

- development of strategies and technologies that support the transfer of tacit knowledge

- focus on continued development of individual-level tacit knowledge." (Terri L. Griffith, John E. Sawyer, Margaret A Neale, 2003, page 283)

Organizational knowledge is dependent on more tacit processes, such as enactment, to be transferred into the technology, structures and routines that retain knowledge for further organizational use. Authors of this paper believe that suggested above actions may mitigate these limitations to knowledge transfer in teams that are more virtual in nature.

5.3.1 Now that we have a good idea about the key followers in the two most effectuated by Polanyi subject areas: "Business Economics" and "Computer Science", we are going to a few other subject areas that were also effected in significant way: "Engineering", "Psychology" and "Education".

The first paper is from Engineering and is written by Jeffrey L. Cummings and Bing-Sheng Teng in year 2003 and has been cited 101 times, the name of the paper is: "Transferring R&D knowledge: the key factors affecting knowledge transfer success".

The authors of this paper use the study of knowledge transfer within more than 15 industries, between both domestic and international R&D partners in order to find out what are the factors that cause the knowledge transfer to be successful. In course of their research, they found that there are several important variables: 1. First one is that R&D units understanding where the desired knowledge resides within the source is absolutely necessary. 2. The second factor that has to be known is the extent to which the parties share similar knowledge bases. As for the third and the fourth knowledge that is necessary is the extent of interactions between the source and the recipient to 3.

transfer the knowledge, as well as the extent to which the 4. participation in an articulation process through which the source's knowledge is made accessible to the recipient. This four variables are very important for R&D knowledge transfer, as without them being known complications may arise (decrease in efficiency, opportunity innovations & knowledge accumulation loss).

In their study's authors have noticed some problems with knowledge transferability, as not all of the knowledge can be transferred explicitly:

"Since new product development activities are exploratory in nature, there is usually a high degree of ambiguity and uncertainty about the knowledge to be transferred. Moreover, knowledge transfer packages are not comprised of only written documents and codified information, as "explicit knowledge must rely on being tacitly understood and applied" (Polanyi, 1966a, p. 7). " (Jeffrey L. Cummings and Bing-Sheng Teng, 2003, page 40)

As their research went on, it became more clear that they don't exactly agree with Polanyi on the matter that tacit knowledge should be at the core of organizational knowledge, because of its difficulty of transferability. Yet to a degree they do believe that tacit knowledge is present in any existing system of knowledge transfer.

5.3.2 Next key follower is from "Psychology" subject area and he has been cited 419 times. The author is Anthony J. Marcel and the name of his paper is "Conscious and Unconscious Perception - an approach to the relations between phenomenal experience and perceptual processes", published in 1983.

In his paper Marcel addresses cognitive psychologists, hoping that they at least to some degree will reconsider their views. More specifically he discusses how the conscious perception and non-conscious perceptual processes are outlined. Analyzing the core basis of rejecting the assumption that phenomenal experiences are either identical or direct reflections of representations provided by perceptual processes. These processes are divided into two: conscious and non-conscious:

"Nonconscious perceptual processes automatically redescribe sensory data into every representational form and to the highest levels of description available to the organism."

(Anthony J. Marcel, 1983, page 238)

"Conscious perception requires a constructive act whereby perceptual hypotheses are matched against information recovered from records, and serves to structure and synthesize that information recovered from different domains." (Anthony J. Marcel, 1983, page 238)

He presents further description on this two types of perceptual processes, however what interests us in his work is how he distinguishes the knowledge that is formed and used in those process. While discussing the conscious and non-conscious processes he finds it important to answer what kind knowledge exist and how are they connected to them. Here he refers to Polanyi's description of tacit knowledge and follows it up with further elaboration on this subject with other sources:

"It is thus appropriate to discuss at this point another distinction between conscious and unconscious processes-the form of the knowledge and representations upon which such processes operate... . In Polanyi's (1964, 1966) terms, the tacit and explicit (i.e., nonconscious and conscious) descriptions of an event may be quite different. Turvey (1974) has already made this point and presented some of the evidence which follows. Wickens (1970) has argued that release from proactive interference (PI) in short-term memory (improvement in recall performance following continuous deterioration) reveals psychological categories by dint of differences in coding between classes." (Anthony J. Marcel, 1983, page 255)

Afterwards he discusses each of those work more closely, however the important fact is that he relied on Polanyi's description of tacit knowledge and unlike many of other key followers he did not deviate or make significant changes to Polanyi's belief about tacit knowledge.

5.3.3 The last paper that I am going to discuss belongs to the "Education" subject area and has earned 127 citations. The authors are Neville Hatton and David Smith with their paper: "Reflection in teacher - education - towards definition and implementation", published in 1995.

Authors of this paper are addressing a problem in education where even though many teachers claim to have reflection as their goal in their preparation programs, the definition Reflection and how it might be fostered in student-teachers is not exactly clear. Hatton and Smith provide a report of review of literature on reflection, mainly focusing on strategies which assist its development. They follow up this report with research project where types of reflection have been defined and applied to an analysis of student writing, afterwards constructing a framework for different types of reflection as grounds for future research development.

We all know what reflection is as a process, but a reflective thinking generally addresses practical problems, allowing for doubt and perplexity before possible solutions are reached. In order to see all aspects of reflection, authors use Schon's (1983) framework to able to incorporate all kinds of reflection and this is how their research interacts to Polanyi's idea of Tacit Knowledge:

" Schon's framework is able to incorporate all levels or kinds, including critical reflection. His reflection-in-action and reflection-on-action involve an epistemology of professional practice based upon knowing-in-action and knowledge-in-action (Alricher & Posch, 1989; Munby & Russell, 1989). Such tacit knowledge is derived from the construction and reconstruction of professional experience, in contrast to applying technical or scientific rationality (Adler, 1991;Polanyi, 1958, 1667; Sch6n, 1983, 1987). (Neville Hatton and David Smith, 1995, page 35)

From this paper we can observe how the idea of tacit knowledge plays a significant role in education, reasoning it by the fact that it governs the process of learning, more specifically as researched in this paper - "Reflection" and different teaching skills. Hatton's and Smith's view on tacit knowledge is very similar to Polanyi's, though it does seem that unlike Polanyi they believe that tacit knowledge is capable of being converted in to explicit knowledge back and forth.

VI. Discussion and Conclusion

Now that I have presented all of the analytical data and examples of direct effects of Polanyi's work on different knowledge fields, I think we can continued to discussion of those findings.

The very first thing that catches the eye is that in recent years the citation number of Polanyi's has dramatically increased in comparison to the previous years. Starting from 1995-1996 the very first jumps could be observed (Table 1 & 2). With each year the number of citation has risen by around 10 citation each year (1995-2006) and in average by additional 26 per year in 2006-2010. Such increase can be practically called an undeniable fact of some sort of effect or influence of Polanyi's Tacit Knowledge on the way people view knowledge in general. The results that I have shown later on in (Table 3) help us to easier see the actual change in the growth rate of citation number and it gives enough grounds to make an assumption that citation number growth rate increases with time. Even if in period of 1975-1995 there was no significant growth experienced in number of citations, it was still present in an approximate amount of 0.05% per year. Another interesting trend that I have noticed from analysis is that Most of publications that cited Polanyi came from USA, around 37%, followed by England with 15% and Canada with 7%. It is really hard to establish the reasons for this, however my belief is that there were a few factors involved. The most obvious reason is that the original work of Polanyi was written in English, however it would be more appropriate to assume that the dominant position of USA as the largest contributor should be taken as a given, this can be supported because they have a lot more researchers spread over a very large territory. Also in comparison to the findings in other important papers, we can observe the same dominant position of USA (example: Donald C Hambrick's and Phyllis A. Mason's: "Upper Echelons", 1984).

If we look at the papers that were discussed in depth, then we will see that there is an interesting situation going on, in terms of how they used and defined Tacit Knowledge. Most of the Key followers used the Polanyi's original definition of Tacit Knowledge until the beginning of 90's, however afterwards many diverted from the original idea. Good examples would be: Nonaka (1994), Maryam Alayi and Leidner (2001) - as they didn't agree with Polanyi that Tacit Knowledge cannot be converted in to explicit and back again. They ether found a way to convert it, thus proposing a knowledge creation mechanism for organizations, or defined the two as interlinked, being connected to each other in such a way that one cannot be separated from the other beyond a certain point. Another point of Polanyi's original idea that is changed or refused to be accepted - is that science should not be as explicit as it is. This idea however, didn't even get a chance to be tested out, as tacit knowledge cannot exist without explicit.

To put it all in an nutshell, Polanyi's breath managed to reach numerous knowledge fields and leave a significant mark and his idea managed to break the confusion between what used to be called know how and know about.

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