Paper to be presented at the DRUID Academy 2013

on

DRUID Academy 2013
at Comwell Rebild Bakker, Rebild/Aalborg

The Validity of Text Based Indicators of Firms' Exploration & Exploitation Activities

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Abstract

State-of-the-art: Measuring exploration and exploitation activities of firms has been a popular topic since March's 1991 pioneering work on "Exploration and Exploitation in Organizational Learning". Several empirical studies have confirmed that balancing exploration and exploitation can bring superior firm performance, and the interest in the topic has grown rapidly. Recent studies have used different indicators to measure these concepts at the firm level, including publication, patent and survey based indicators. An alternative indicator has been developed by Uotila (2009) using document content analysis techniques to search for March's (1991) keywords related to exploration and exploitation. This paper has drawn attention in the field. However, I argue that Uotila (2009) contains insufficient validity analysis. In an analysis mimicking the Uotila method, I show that the use of March's keywords is unlikely to lead to valid indicators that allow dintinguishing exploration and exploitation.

Research Gap: The objective of this paper is to examine the validity of text based indicators on the basis of March's (1991) keywords to define exploration and exploitation activities of firms, and to provide a valid content analysis based indicator of exploration and exploitation activities. The validation of text-based indicators is an important contribution to innovation management research, as the method has broad application potential.

Theoretical arguments: Uotila et al. (2009) proposed a new methodology to operationalize the exploitation and exploration concepts, namely computer-assisted coding of texts. The basic idea of this method is to perform a content analysis by using March's keywords (exploration: search, variation, risk taking, experimentation, play, flexibility, discovery, innovation; exploitation: refinement, choice, production, efficiency, selection, implementation, execution) on a set of documents that contain information on firms' business activities (e.g. press releases). Uotila et al. (2009) calculate the relative exploration orientation of firms by dividing the number of 'explorative' articles by the total number of articles of the firm using keyword counts. However, Uotila et al (2009) do not conduct extensive validity analysis. The use of personal judgment of human coders in the instruction process and a moderate Cohen Kappa ratio (0.68) also raises concerns about the measures used. The objective of the current study is to examine the validity of text-based indicators for measuring exploitation/exploration activities.

Method: In order to assess the validity of a content analysis based indicator three empirical techniques have been proposed in the content analysis literature: experimental and instructional interventions, examination of group differences, and consistency with other methods (Messick, 1989). The first method cannot readily be implemented since interventions in the innovation process at the firm level are hard to observe. This study focuses on the latter two empirical validation techniques. By using factor analysis, we observe whether exploration and exploitation keywords have different distributions and load into separate factors. By comparing text based indicators with commonly-used patent-based and publication-based indicators of exploration and exploitation, we conduct a further validity test. I study more than 1 million documents on 180 firms in technology intensive industries.
Results: I show that the use of content analysis using March's original keywords does not lead to valid indicators of exploration and exploitation. The two indicators do not form separate factors, and the indicators correlate negatively rather than positively with indicators based on publication and patent data. I do maintain that using content analysis on firm documents (such as press releases) can be a valid technique to measuring exploration and exploitation activities of firms. I explore a set of new keywords leading to more representative explorative and exploitative indicators that do pass the validity tests.
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Measuring the Validity of a Text Based Indicator for Exploration & Exploitation Activities of Firms

(Working Paper in Progress)

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Abstract

Measuring exploration and exploitation activities of firms has been a popular topic since March's 1991 study of "Exploration and Exploitation in Organizational Learning". Especially after academic studies confirm the fact that balancing exploration and exploitation will bring superior performance, the interest to that topic has grown increasingly. Several empirical studies have confirmed that balancing exploration and exploitation can bring superior firm performance, and the interest in the topic has grown rapidly. Recent studies have used different indicators to measure these concepts at the firm level, including patent, publication and survey based indicators. An alternative indicator has been developed by Uotila (2009) using content analysis techniques to search for March's (1991) keywords related to exploration and exploitation. The objective of this paper is to examine the validity of text based indicators on the basis of March's (1991) keywords to define exploration and exploitation activities of firms and to provide a valid content analysis based indicator of exploration and exploitation activities. I argue that Uotila (2009) contains insufficient validity analysis. In an analysis mimicking the Uotila method, I show that the use of March's keywords is unlikely to lead to valid indicators that allow distinguishing exploration and exploitation.

Introduction

Measuring exploration and exploitation activities of firms has been a popular topic since March's 1991 study of "Exploration and Exploitation in Organizational Learning". Especially after academic studies confirm the fact that balancing exploration and exploitation will bring superior performance, the interest to that topic has grown increasingly. Current studies use different indicators to measure these concepts at the firm level including publication, patent and survey based indicators. An alternative indicator has been developed by Uotila (2009) by using the keywords in March's (1991) definition of exploration and exploitation via content analysis technique. This paper has gathered great attention in the field and has been cited several times. However the validity of this indicator is questionable, since the validity depends on the chosen keywords and the implementation of the content analysis. In this respect, the objective of this paper is to check the validity of this text based indicator by using March's (1991) keywords to define exploration and exploitation activities of firms.

In order to maintain the validity of a content analysis based indicator three empirical techniques have been proposed in the content analysis methodology literature: experimental and instructional interventions, examination of group differences and consistency with other methods (Messick, 1989). The first method is not applicable to real life innovation data since interventions in the innovation process at the firm level are hard to observe. This method is open to subjectivity issues and not retrievable. In this study, the last two empirical techniques have been used to assess the validity of content analysis based indicator in measuring exploration and exploitation activities and prospective research steps for developing a better indicator have been provided.

This paper will proceed as follows. First, theory and prior researches will be given especially focusing on Uotila's (2009) study. Afterwards the data, sample and methodology will be discussed in order to give a brief introduction about the validation process. In the next part, the research results will be summarized for the validation of existing March's (1991) keywords. Following the research results will be summarized for finding new keywords and for validating new keywords. Finally the discussion and conclusion will be given while examining the limitations and future research avenues.

Theory & Prior Researches

Since Schumpeter (1934) emphasizes the explorative and exploitative notion of innovation processes, a great deal of attention has been put on this area to understand the system of innovation in a firm. Especially March's 1991 article opened a new era after Schumpeter and showed the importance of balancing those activities to improve firm survival and performance (O'Reilly and Tushman, 2004; Raisch et al., 2009). According to March's definition exploration refers to the creation of new capabilities by means of activities such as fundamental research, experimentation, and search whereas exploitation refers to leveraging of existing capabilities by means of activities such as standardization, upscaling and refinement. Following studies refer to March and express the distinction by long-term effectiveness vs short term efficiency (Levinthal & March, 1993), search depth vs search scope (Katila & Ahuja, 2002), technology vs market knowledge (Nerkar & Roberts 2004), sensing vs seizing (Teece, 2006), adaptability (Gibson & Birkinshaw, 2004), and fluidity vs stability (Schreyogg & Sydow, 2010) and etc. There are a lot of empirical researches that support March's view of balancing exploration and exploitation activities (He & Wong, 2004; Jansen et al., 2006; Lavie et al., 2009, Uotila et al., 2009; Venkatraman et al., 2007; Belderbos et al., 2010, Tushman & O'Reilly, 1996) and argue that ambidexterity leads to superior performance outcomes and survival. However balancing exploitation and exploration is not straightforward and there is still a discussion about how ambidexterity can be achieved, what is the optimal balance between exploration and exploitation, and which factors can determine the effects of ambidexterity etc. (Radner & Rothschild, 1975; Gupta, Smith, & Shalley, 2006; March, 1991; Tushman & O'Reilly,1996; Van Looy, Debackere & Martens, 2005; Raisch et al., 2009). In order to give a satisfying answer to those questions an accurate indicator is essential.

The existing literature relied heavily on two methodologies, survey-based indicators and patent-based indicators. Survey based data (He & Wong, 2004; Visser, Weerd-Nederhof, Faems, Song, van Looy, Visscher, 2010) includes interviews with key R&D people in organizations and covers detailed information about innovation processes (Mohnen-Roller, 2005). However this method has its own drawbacks such as low international and technology comparability, data bias as a result of subjective judgments, potential heterogeneity, and endogeneity problems (Kleinknecht, Van Montfort & Bouwer, 2002). Patent-based indicators are also commonly used in the literature since they are easy to collect and compare and include detailed information (see, for example, Belderbos et al., 2010; Rosenkopf & Nerkar,

2001; Katila & Ahuja, 2002). These indicators rely on technology class information on patents, and consider patents as explorative if they are situated in technology domains that are new to the firm. Patent data have its own disadvantages as well; not all innovations are patented since patenting is one among many protection strategies and they only provide a partial view on firms' technology activities. Additionally, it is often unclear whether these survey and patent based indicators are consistent with the conceptual definitions of exploration and exploitation (Gupta et al., 2006).

Recently, Uotila et al. (2009) proposed a new methodology to operationalize the exploitation and exploration concepts, namely computer-assisted coding of texts. The basic idea of this method is to perform a content analysis (employing computer software) by using March's keywords (exploration: search, variation, risk taking, experimentation, play, flexibility, discovery, innovation; exploitation: refinement, choice, production, efficiency, selection, implementation, execution) of a set of documents that contain information on firms' business activities (e.g. press releases). Uotila et al. (2009) calculate the relative exploration orientation by dividing the number of explorative keyword hits to total number of keyword hits. This new indicator broadly measures the notion of exploration within all firm activities. Although conceptually appealing, it is unclear to what extent this new indicator is valid. Uotila et al. study does not also take into consideration the length and the context of the articles. The manual validation of this new indicator arises questions on the accuracy of new indicators. The use of personal judgment of human coders in the instruction process and a moderate Cohen Kappa ratio (0.68) support our concerns about the validity of Uotila et al. (2009) measure. Therefore the primary objective of this study is to examine the validity of content analysis based indicator for measuring exploitation/exploration activities in a large sample of firms, first by using factor analysis method to observe how exploration and exploitation keywords distributed, secondly by looking for within and between group correlations and lastly by comparing this indicator with commonly-used patent-based indicators. We believe that the validation of content analysis based indicator is a crucial contribution to the innovation management literature since this new indicator is ex-ante, accessible and retrievable. This universal method can also be useful when comparing different technologies over time across sectors since the data is comprehensive and detailed.

Sample & Data

The sample firms are R&D-intensive European, U.S., and Japanese firms in five industries: (1) nonelectrical machinery; (2) pharmaceuticals and biotechnology; (3) chemicals; (4) IT hardware (computers and communication equipment); and (5) electronics and electrical machinery (The detailed information can be found in Belderbos et al., 2010 JPIM paper).

In order to carry out the content analysis, Lexis-Nexis database is used to gather the press release articles relating to innovation and R&D related activities only[1]. The Lexis-Nexis database consists of 1,030,315 articles for 2,767 subsidiary company names (including parent firms and their subsidiaries), 180 parent names and covers the time period from 1993 to 2006. Firm level patent data on parent firms and their majority owned subsidiaries were collected from European Patent Office (EPO). The variables are constructed from patent application data instead of patent grants since patent applications tend to give a more complete picture in terms of exploratory activities. Only for the pharmaceuticals and biotechnology sector (37 parent firms) we extracted publication data from yearly updates of the Science Citation Index database of ISI/Thomson Scientific, including peer-reviewed papers of the types article, letter, note and review. The patent data and publication data have been used to check the consistency of new content analysis based indicator for validation.

Methodology & Variables

The content analysis method has been used to measure the text based indicator by using press release documents. Content analysis has been defined as a systematic, replicable technique for compressing many words of a text into fewer content categories based on explicit rules of coding (Weber, 1990). In order to run the validity test, a patent based indicator has been used to check the consistency of text based indicator. After cleaning the missing, duplicated and non-R&D articles we come up with 245,389 articles for 1318 subsidiary firms and 168 parent firms that contain roughly the same number of firms in each industry for each region of origin. We drop subsidiary firms if they have less than 5 articles and articles are not equally distributed across parent firms (Larger firms have high number of articles published). To calculate the relative exploration ratio, the content analysis method is used via Gawk software package. We experimented with different sets of keywords to classify articles as indicative of technology exploration or exploitation activities where the basic aim is to catch the frequency

[1] Lexis-Nexis has its own keywords to identify which articles are related to which issue. We give "innovation", "R&D" and "research and development" keywords in our dataset request.

of exploitation and exploration keywords for each firm and year combination. Keyword roots for exploitation can be summarized as 'execute', 'choice', 'efficien', 'exploit', 'implement', 'production', 'refine', and 'select' whereas for exploration they are 'discover', 'experiment', 'explor', 'flexib', 'innovat', 'play', 'risk', 'search', and 'variation' (Uotila, 2009 based on March, 1991). After keyword matching analysis, the relative exploration ratio is calculated by dividing the number of exploratory words by the sum of exploratory and exploitative words per company-year (Uotila et al., 2009). Articles were classified as technology exploitation or exploration, and linked to parent firms using firm consolidation information that was available prior to the study. We would first examine the distribution of keywords across two concepts; exploration and exploitation with factor analysis. Following, we would discuss the within and between group correlations. And lastly, this indicator is compared with patent based indicator in the following steps of the analysis to enhance the validity of this new methodology.

The exploration orientation is calculated also with the patent data by using technology class information. A patent is considered as an explorative one if it is situated in a new technology domain. A technology domain is defined as new to a firm in year t, if the firm (i.e., firm subsidiaries in year t) did not patent in this technology domain in the past five years (t_5 to t_1) The explorative orientation of a firms is calculated by dividing the number of explorative patents to total number of patents (Detailed information can be found in Belderbos et al., 2010 study). For only pharmaceuticals and biotechnology industry, publication based explorative orientation has also been calculated by dividing the number of academic articles published in basic research journals to total number of academic articles published.

Validation of Existing Keywords

Descriptive Analysis

Exploitataion	Exploration
Choice 0.082	Discover 0.33
Efficien 0.29	Risk 0.39
Execut 0.71	Play 0.29
Exploit 0.03	Flexib 0.12
Implement 0.20	Search 0.07
Production 0.76	Explor 0.07
Refine 0.05	Experiment 0.06
Select 0.25	Variation 0.07

Table 1. March 1991 keywords & mean values

Table 1 above shows the mean values of March's keywords to define exploration and exploitation activities within the firm. The "ratiotext" measure is calculated by dividing the total count of exploration keywords by total count of all keywords per each subsidiary firm. Following, the mean value is taken the data is aggregated at the parent firm level.

Table 2 below shows the summary of descriptive statistics about the data and the two main variables: "ratiopatent" and "ratiotext". Reported values are average values and standard deviations. The average length of an article is 900 words approximately and each firm has 164 articles on average. The patent indicator measure "ratiopatent" shows the ratio of firm patents in new technology classes in total patents and takes a value of 21%. In a parallel vein, "ratiotext" measures the number of explorative hits divided by total explorative and exploitative hits at the article level' and takes the mean value of 33%.

Variable	Mean	Std. Dev.
# of articles	164,6	450
# of word per article	900	1250
# of total patents	128,2	263
ratiopatent	0,21	0,21
ratiotext	0,33	0,18

Table 2. Descriptive Statistics

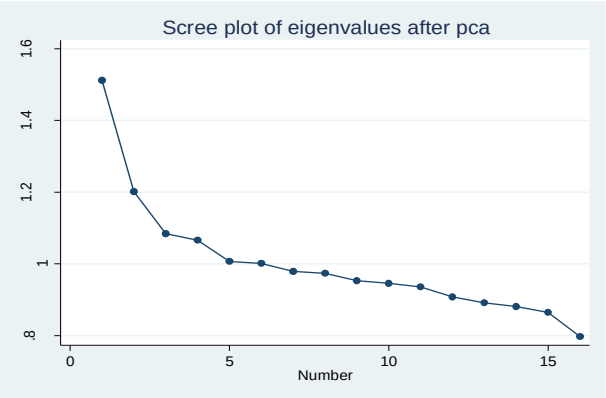
Following, Table 2 compares the averages and standard deviations of patent based and text based explorative orientation of firms in different sectors. The results indicate that the level of patent based indicator is the highest in engineering and machinery whereas text based indicator peaks in pharmaceuticals and biotechnology industry. This initial descriptive result leads us to make further tests.

sector	ratiopatent	ratiotext
Chemicals	0,19	0,28
	(0,14)	(0,17)
ELEC	0,19	0,32
	(0,22)	(0,13)
Engineering&Mach	0,31	0,29
	(0,22)	(0,20)
IT Hardware	0,18	0,31
	(0,22)	(0,14)
Pharm&Biotech	0,14	0,51
	(0,20)	(0,16)
Average	0,20	0,33
	(0,21)	(0,18)

Table 3. Comparison of patent and text based indicators per sector (Means and Standard Deviations)

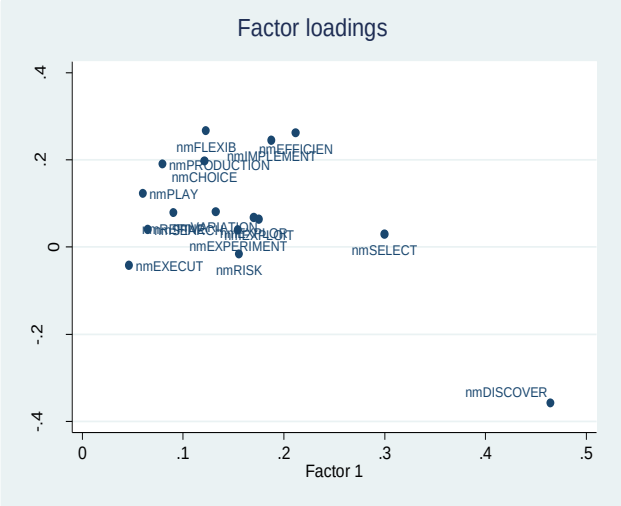
In order to visualize how above keywords distributed across two concepts, exploration and exploitation we run the factor analysis. The results of the confirmatory factor analysis can be

seen in the graph below. The screeplot table clearly shows that these 16 keywords are not perfectly loaded on two factors, exploration & exploitation. In order to have a clear understanding, we forced the data to load on two factors by using maximum likelihood method via varimax rotation (Other methods also give the similar results, ml and varimax has been chosen because of better GFI values). The factor analysis results are parallel with the previous results. The uniqueness values for each keyword are over 0.90 (except discovery). This result indicates that keywords are not perfectly loaded on two factors and they are simply not discriminated from each other.



Graph 1. Screeplot of eigenvalues after pca

The factor loadings, uniqueness values and graph can be seen below. The graphical representation clearly shows that only 'discover' load to factor 1 (exploration). One may notice that 'flexib and production', and 'experiment and execut' keyword pairs have almost identical positions although they have the opposite meanings.



Graph 2. Factor loadings & uniqueness values

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Uniqueness
nmCHOICE	0.1212	0.1978	0.9462
nmDISCOVER	0.4646	-0.3586	0.6555
nmEFFICIEN	0.2117	0.2618	0.8866
nmEXECUT	0.0466	-0.0415	0.9961
nmEXPERIMENT	0.1544	0.0395	0.9746
nmEXPLOIT	0.1753	0.0641	0.9652
nmEXPLOR	0.1700	0.0682	0.9664
nmFLEXIB	0.1228	0.2668	0.9138
nmIMPLEMENT	0.1877	0.2455	0.9045
nmPLAY	0.0603	0.1225	0.9814
nmPRODUCTION	0.0797	0.1910	0.9572
nmREFINE	0.0904	0.0785	0.9857
nmRISK	0.1555	-0.0161	0.9756
nmSEARCH	0.0652	0.0411	0.9941
nmSELECT	0.2998	0.0296	0.9093
nmVARIATION	0.1325	0.0813	0.9758

The uniqueness values also shows that these keywords are not uniquely loaded to either factor. This results in factor analysis support our suspicions about the validity of content analysis based indicator by using March's keywords straightforwardly. Can we use March's keywords to measure exploration and exploitations activities of firms?

Method 1

One method to assess the validity of a content analysis based indicator is to look for the within and between group correlations. These correlations simply describe how strongly units in the same group resemble each other and differ across groups. Therefore, if there is good set of keywords, a high correlation within the keyword groups of exploration and exploitation separately should be observed, and a negative correlation between exploration and exploitation keyword groups should be obtained.

	Exploitation	Exploration
Average interitem covariance:	0,02	0,01
Number of items in the scale:	8	8
Scale reliability coefficient:	0,1383	0,1076

Table 4. Within group correlations

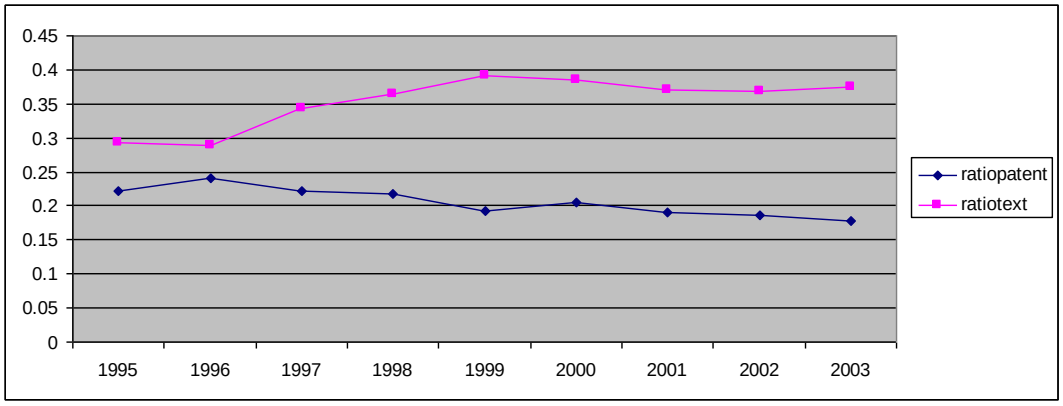
The results in Table 4 indicate that the within group correlations are small. Although there is no consensus about the minimum value of correlation in the literature to get healthy results, it is expected to have at least 70% correlation within the groups if the units of the groups measure the same concepts successfully (Neuendorf, 2002), however the results only show 10% correlation for each concept. The results show that neither exploitation nor exploration is measured successfully. Additional cluster analysis and discriminant analysis test results also support low within group correlations.

Between group correlations of exploration and exploitation keyword groups at the absolute level is equal to 0.13. We expect to find a negative correlation or no correlation since exploration and exploitation measure two different concepts. However, a positive correlation has been found.

Method 2

Another and widely accepted method to validate a content analysis based indicator is to look for the consistency between different indicators. For this purpose we look for the correlation between text based and patent based indicators. The results are opposite to our expectations. The correlation is equal to -0.14 and this negative and significant value clearly show that there

is negative correlation between text based and patent based indicators (Belderbos, 2010). This negative relationship can also be found from a different perspective as seen in the following graph.



Graph 3. Time trend of exploratory orientation of firms based on patent and text based indicators

The graph represents that there is a slight decline in the exploratory orientation of firms based on patent indicator in time. However the text based indicator exhibits the opposite and shows that firms are more explorative in their R&D activities in 2004 compared to 1995. This negative correlation can be a result of pharmaceuticals and biotechnology industry. Therefore, we used a third indicator to assess the validity of text based indicator based on ISI publication data for 37 pharmaceuticals and biotechnology firms between 1995 and 2000. The "ratiopub" variable is simply calculated by dividing the number of articles published in basic research journals to all published journals. The correlation analysis results can be seen in the following table.

	ratiotext	ratiopatent	ratiopub
ratiotext	1		
ratiopatent	-0.0655	1	
ratiopub	0.0198	-0.078	1

Table 5. Correlation between patent, text and publication based indicator

For this particular industry, the correlation between patent and text based indicator is negative. But the absolute value of this value is lower than it is for all industries which negates the possibility that pharmaceuticals and biotechnology industry is the main cause of the anomaly. On the contrary, the text based indicator is positively related with the publication based indicator, but this relationship is not significant.

In the light of the empirical evidences, we can argue that the text based indicator of Uotila et al. (2009) based on March's 1991 keywords is not a valid indicator for measuring technological exploration and exploitation orientation of firms. A primary explanation can be that March's 1991 article is about organizational learning and he did not define these keywords for empirically measuring the technological exploration and exploitation activities of firms. These keywords theoretically and logically exhibit the difference between these two concepts but using them as a hint in press release articles does not actually capture the exploration and exploitation notion. However this does not mean that each and every March keyword is misleading. The perfectly loading of 'discover' keyword supports this point. This keyword is widely used in biotechnology and it really captures the exploration activity. Solely the rest of the keywords are more general and it is easy to encounter them in any press release article. Therefore finding more focused keywords is the first step for developing a valid text based indicator for measuring exploration and exploitation activities of firms.

In the light of this evidence, we direct our research focus to find new and valid keywords that successfully captures the exploration and exploitation activities of firms in their research and development processes. In order to do that we search for most frequent keywords in a sample of articles and we intuitively assign these keywords to exploration and exploitation and retrieve the empirical analysis for validation including factor analysis, within and between group correlations and correlation across different indicators. Empirical analysis shows that a text based measure with better keywords via using content analysis techniques is a promising indicator for measuring exploration and exploitation activities of firms.

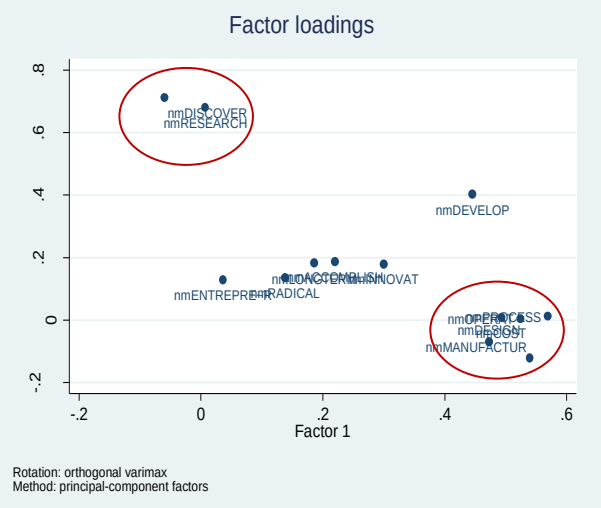
Search for New Keywords

New keywords are intuitively selected among the most frequent keywords. In order to find the most frequent keywords a software program called NVIVO is used. The program automatically gives the most frequent keywords by taking into account their synonyms. A sub-sample of randomly selected articles (approximately 15% of all articles) are uploaded to the NVIVO and the most frequent 200 keywords are examined. During the examination process irrelevant (and, of, are, yes, etc...) and nonrelated common keywords (firm, ceo, sales, industry etc...) are eliminated. Among the meaningful keywords, explorative and exploitative ones are intuitively selected. Some of these keywords are also synonyms of March's 1991 keywords such as 'manufacture' (production), 'cost' (efficient), 'operation' (implement). The following table shows the list of new keywords.

EXPLORATION -New	EXPLOITATION-New
research	cost
discover	design
entrepreneur	manufacture
radical	operate
innovat	process
accomplish	develop

Table 6. List of new keywords

In order to visualize how above keywords are distributed across two concepts, exploration and exploitation, we run the factor analysis. The results of the factor analysis can be seen in the graph below. In order to have a clear understanding, we forced the data to load on two factors by using maximum likelihood method via varimax rotation (Other methods also give similar results; maximum likelihood and varimax has been chosen because of better GFI values). The factor analysis results are promising. The keywords 'design', 'process', 'cost', 'manufacture', 'operation', 'discover' and 'research' are perfectly loaded on two factors and they are meaningfully discriminated from each other. The uniqueness values also support this conclusion.



Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Uniqueness
nmACCOMPLISH			0.9170
nmCOST	0.4927		0.7572
nmDEVELOP	0.4448	0.4029	0.6397
nmDESIGN	0.4723		0.7720
nmDISCOVER		0.7115	0.4902
nmENTREPRE~R			0.9821
nmINNOVAT			0.8782
nmLONGTERM			0.9321
nmMANUFACTUR	0.5398		0.6938
nmOPERAT	0.5240		0.7254
nmPROCESS	0.5685		0.6767
nmRADICAL			0.9626
nmRESEARCH		0.6811	0.5361

(blanks represent abs(loading)<.4)

Graph 4. Factor loadings and uniqueness values of new keywords

The graphical representation clearly shows that 'discover' and 'research' load to factor 2 (exploration). Similarly, 'process', 'cost', 'design', 'manufacture' and 'operate' load to factor 1 (exploitation) successfully. The clear discrimination between two factors support our idea that using different keywords will create a better text based indicator for measuring exploration and exploitation activities of firms. In the following parts we will check whether new

keywords can provide the validity requirements of a text based indicator using content analysis technique. In the following analysis we will use only the successfully loaded keywords and discard the keywords (develep, innovat, radical, accomplish, entrepreneur) that do not load to any of the factors successfully.

Method 1

One method to assess the validity of a content analysis based indicator is to look for the within and between group correlations (Messick, 1989). As we noted before, if two or more keywords are representing one common notion, the within correlation between these keywords should be high. The following table shows the within group correlations for new exploration and exploitation keywords.

	Exploitation-New	Exploration-New
Average interitem covariance:	0,46	0,41
Number of items in the scale:	5	2
Scale reliability coefficient:	0,4274	0,2041

Table 7. Within group correlations for new keywords

The results in Table 7 indicate that the within group correlations are promising. Although they are below 0.70, we can still interpret that these keywords are more valid than those of March 1991 in terms of representing exploration and exploitation activities (Neuendorf, 2002). The potential reason for a low correlation value is the small number of keywords. The more valid keywords we find, the higher the correlations we get. The results show that especially exploitation keywords are highly representative.

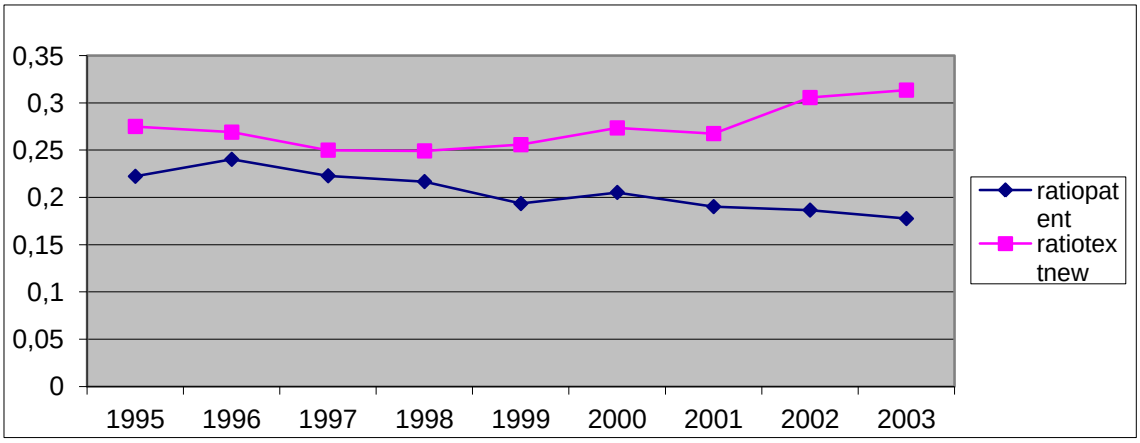
Similarly between group correlations of new exploration and exploitation keyword groups at the absolute level is equal to -0.18. We expect to find a negative or no correlation since exploration and exploitation measure two different concepts. The negative correlation found is in line with our expectation. We interpret this result as these new keyword groups are measuring two different negatively related concepts such as exploration and exploitation.

Method 2

The second validation method is to check the consistency between different indicators (Mesick, 1989). If a new indicator is a valid indicator, it should have positive correlation with other valid indicators that have been developed previously. For this purpose we look for the correlation between text based and patent based indicators. Patent based indicators have been

used in the literature several times and they are considered as valid indicators (Belderbos, et al., 2010) The new text based indicator (ratiotextnew) is the ratio of explorativeness and it is calculated by dividing the valid exploration keywords to all keywords (Uotila, 2009). The correlation is equal to 0.10 and this significant correlation clearly show that there is a positive and significant correlation between new text based indicator and patent based indicator.

The graphical representation below also shows two indicators are correlated. Especially from 1995 to 2001 the new text based indicator and patent based indicator have shown a similar trend. We believe that this difference after 2001 can be captured by taking into account more valid keywords. In order to strengthen our argument, we will check the validity of the new text based indicator by using a different indicator other than patents namely publication based indicator which we already defined as 'ratiopub' only in biotechnology sector. The correlation analysis results can be seen in the following table.



Graph 5. Time trend of exploratory orientation of firms based on patent and new text based indicators

	ratiotextnew	ratiopatent	ratiopub
ratiotextnew	1		
ratiopatent	0.0489	1	
ratiopub	0.2555	0.0956	1

Table 8. Correlation between patent, new text and publication based indicators

For this particular industry, the correlation between patent and text based indicator is positive but relatively small. More importantly the correlation between, new text based indicator and publication based indicator is highly positive and significant. This new finding supports our idea that using content analysis with better keywords will create a valid text based indicator .

Discussion

The results of this study can be criticized in terms of time difference between the publication dates of articles and patent application dates. We examined a number of alternative methods including using different time lags. Analyses using 1, 2 and 3 years time lag have been conducted as well and they all resulted in similar conclusions. Robustness checks also have been performed during the analysis. One may also argue that press release articles are not a good representative of innovation and firms are more likely to overemphasize their R&D activities. We believe that the comprehensive datasets including large and reputable firms overcome this potential bias naturally.

One other concern is that our sample is a subsample of Uotila et al. study with more focused R&D articles (only R&D activities rather than all firm activities) so a direct comparison cannot be made. Our main reason to apply this method in R&D and technological activities of firms is that it is easier to find a valid and reliable indicator (patents) for R&D activities instead of all activities of firms. Although Uotila et al.'s dataset include all firm activities including marketing, HR etc., we believe their results can also be reduced to only R&D activities (2009), since they did not take into account the topic of article as a control variable (whether the article is about marketing, HR or R&D) which means that they do not differentiate between firm activities. The retrieval of this study can be done by finding more valid keywords for measuring exploration and exploitations activities of all firm activities rather than only R&D activities.

Using content analysis method in press release articles to measure R&D activities is a strategically appealing method. However focusing solely on March's keywords is not adequate. Ultimately, innovation is a multidimensional and complex phenomenon in its nature. Our results show that better keywords provide a better indicator. In further studies an alternative inductive approach can be followed by searching the most frequent keywords in each type of press release documents. First each article is classified manually as either exploration or exploitation. Afterwards the most frequent keywords in each article type are listed. Within this list, the keywords that appear only in one category (explorative or exploitative) can be counted as new keyword candidates. A deeper analysis with more to the point keywords per sector will bring more insights about the R&D activities of firms.

Conclusion

Recently alternative text based indicators have been used in the management and strategy literature as an alternative to patent and survey based indicators (Uotila, 2009; Kaplan & Vakili, 2012). Uotila's (2009) study creates a new text based indicator by using the keywords in March's (1991) definition of exploration and exploitation via content analysis technique for measuring exploration and exploitation activities of firms. However the validity of this indicator is questionable, since the validity depends on the chosen keywords and the implementation of the content analysis. The results of this study have shown that using content analysis in press release or text documents of firms is a valid technique for measuring exploration and exploitation activities of firm activities but if this technique utilizes March's (1991) keywords solely, the indicator is not valid at all. In other words the direct use of March's keywords does not represent firms' exploration and exploitation activities successfully and does not provide a valid text based indicator. The main rationale behind this finding is that, he did not intend to create these keywords for this specific purpose. In the light of the empirical evidences regarding the keywords, we determined a new set of keywords that provide a valid text based indicator including 'discover', 'research', 'process', 'cost', 'design', 'manufacture' and 'operate'. The empirical evidences for the validation of these new keywords show that these alternative keywords create a valid indicator. Further studies should extend the new keyword list by using an extended inductive methodology which we explained in the discussion part briefly. We believe that a valid text based indicator is a crucial contribution to the innovation management literature as it is ex-ante, accessible and retrievable. This widely applicable indicator can also be useful when comparing different technologies over time across sectors since the data is comprehensive, detailed in nature and covers all activities of firms.

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