Implications from Innovativeness Typology on Innovation Performance Measurement: A Bibliometric Analysis

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ABSTRACT

This research contributes to the ongoing since decades existing discussion on research in innovativeness, a term which in the past has been closely related to innovation measurement. Using bibliometric techniques like citation and co-citation analysis combined with factor analysis, cluster analysis and multidimensional scaling we examine the most influential articles that have dealt with the topic. From the resulting overview on research directions in innovativeness we derive a contextual framework for an integrative innovation performance measurement model. In detail our analysis will provide three main findings:

1) There are 4 mayor different well established research streams connected to innovativeness, which focus on different aspects in the innovation-firm performance-chain each of them on different aggregation levels (individual, product, organization). That is consumer innovativeness, personal innovativeness, product innovativeness and firm innovativeness.

2) The different types of innovativeness build up on each other and reflect a so far mostly hidden frame of the chain-of-effects model for the innovation-firm performance relation.

3) We build up a holism aspiring Performance Measurement Framework, which one hand considers all identified performance relevant areas in the bibliometric part and on the other hand incorporates more current topics from the review part.

INTRODUCTION

Innovation performance measurement is a complex task. Delayed observability of effort levels and innovation outcomes make real time innovation control almost impossible (Loch & Tapper, 2002). To overcome these issues researchers have recently proposed to measure an organization's innovation capability as a significant proxy for innovation performance (Adams, Bessant, & Phelps, 2006). However, within this emerging perspective there is little consensus on what should be measured in which way (Birchall, Chanaron, Tovstiga, & Hillenbrand, 2011; Janssen, Möller, & Schläfke, 2011), since the recommended metrics seem to capture only part of the entire innovation process (Neely & Hii, 1998).

Innovation management literature might offer valuable directions to shape a holistic innovation performance measurement system. Innovation management research has a long tradition in studying innovation success factors and their impact on firm performance. Particularly, research on *innovativeness* has dedicated substantial empirical effort to identify key firm capabilities for pursuing competitive advantage through innovation activities (Rubera & Kirca, 2012). Surprisingly, to the knowledge of the authors, there is no publication specifically connecting the relevant findings in the field of innovativeness to research in innovation performance measurement. A possible reason could be the fact that the notion of innovativeness has been inconsistently used for conceptualizing and operationalizing antecedents, competences, moderators or outputs of the innovation process (Calantone, Chan, & Cui, 2006; Hultink & Robben, 1995; Hurley & Hult, 1998; Subramanian & Nilakanta, 1996). Thus, the lack of clarity on key concepts and causal relations keep preventing both researchers and practitioners from developing an effective innovation performance management system based on innovativeness research (Ibrahim, Zolait, Subramanian, & Ashtiani, 2009; Salavou, 2004).

To provide some clarity on the notion of innovativeness and, thus, to provide a more thorough basis for using innovativeness for innovation performance measurement, we use a quantitative bibliometric analysis as an input for a review of past research in innovativeness. Compared to a sole literature review, such an approach is more objective. The fact that we integrate the bibliometric findings with an in-depth analysis of key articles allows to integrate emerging research areas and to identify relevant interrelationships among the most influential research streams (Chabowski, Hult, & Mena, 2011a). Therefore the strength of bibliometric analysis – i.e., revealing an 'invisible' intellectual structure of researchers using quantitative information (Durisin, Calabretta, & Parmeggiani, 2010) - is combined with the possibility of identifying key research areas which did not receive enough attention in the past (Chabowski, Mena, & Gonzalez-Padron, 2011b). In line with previous bibliometric studies (Ramos-Rodríguez & Ruíz-Navarro, 2004) and with methodological guidelines (McCain, 1990) we use citation and co-citation counts in the research domain of innovativeness as an input for three multivariate techniques: 1.) exploratory factor analysis (EFA), 2.) hierarchical cluster analysis (HCA) and 3.) multi-dimensional scaling (MDS). The articles' configurations resulting from each technique and their comparison will offer a more complete evaluation of research on innovativeness (Samiee & Chabowski, 2012). While previous contributions synthesized innovation performance measurement frameworks based only on qualitative reviews (Adams et al., 2006) the present study aims at offering a quantitative grounding for a framework for innovation performance measurement. In summary, the purpose of this study is to differentiate research streams on innovativeness, to integrate them in a more conclusive research framework of the innovation-firm performance-chain and to derive basic guidelines for the design of innovation performance measurement systems.

The rest of our contribution is organized in the following manner: First we give a brief overview on innovation performance measurement and innovativeness research. Second we explain details of the methodology and parameters as well as quality criteria of our bibliometric analysis. Then, in the results section we present joint configurations of the three multivariate techniques followed by a multi method comparison. We conclude with a discussion of future research directions and with a proposal for a conceptual framework for innovation performance measurement.

INNOVATION PERFORMANCE MEASUREMENT AND INNOVATIVENESS EXPLICATED

Research has conceptualized and operationalized 'innovativeness' in a plethora of ways, so that it is even difficult to distinguish it from the general term 'innovation' (Garcia & Calantone, 2002). Mentioned first in the domain of innovation diffusion as "…the degree to which an individual is relatively earlier in adopting new ideas…" (Rogers, 1962: 20), the term has been successively used in several research fields –e.g., marketing, economics, psychology, information technology, and innovation management - assuming context-specific meanings depending on the perspective and preferences of individual researchers (Walsh, Lynch, & Harrington, 2011). In an attempt to summarize the scattered research efforts, 'innovativeness' can refer to people (consumer/ personal innovativeness), to the outcome of innovation projects (product innovativeness), or to the innovation culture of a firm (firm innovativeness). However, the definition and distinctiveness of these three concepts remain unclear, as well as the interrelations among them and with innovation performance (Salavou, 2004). This lack of clarity on key concepts and causal relations contribute to persistent difficulties (both in research and practice) in developing an effective innovation performance management system. Clarifying the relationship between different potential innovativeness constructs could shed light on key issues like: (1) what exactly should be measured to control effectively innovation performance at individual, team and

organizational levels (Kerssens-van Drongelen, Nixon, & Pearson, 2000); (2) whether managers should rely on single or multiple indicators (Hagedoorn & Cloodt, 2003), quantitative and/or qualitative measures, objective and/or subjective measures to capture different aspects of innovation performance (Kerssens-van Drongelen et al., 2000).

Overview on Innovation Performance Measurement Research

A major challenge of research on innovation performance measurement (IPM) is to develop into a coherent body of literature (Adams et al., 2006){Bisbe 2004 #61:710}. Due to this issue there can be identified only few publications offering a systematic overview and understanding of the innovation performance measurement challenge. As a matter of fact most contributions in the field of IPM concentrate on description of specific metrics, of particular design principles for the measurement system or the advantages and disadvantages of applied measurement systems (Godener & Söderquist, 2004). It has especially been noted that there are only few publications which try to derive holistic innovation performance measurement system from an integrative perspective {Chiesa 2008 #284:214}. However, a central problem has always been the absence of specific guidelines on how to consider qualitative innovation inputs like e.g. the inventive ability of an employee (Chiesa, Coughlan, & Voss, 1996; Kuznets, 1962). This is the reason why most current literature on innovation performance measurement is focusing on quantitative data (like R&D figures) that can be captured through "accurate accounting practices" (Panne, 2007). Yet, due to the length of the innovation process, quantitative information on the innovation output is only available *ex post*. As a matter of fact real-time control of innovation activities through quantitative output data gets almost precluded (Loch & Tapper, 2002). Thus, to offer a more realistic and thorough picture of a firm's innovation performance, it becomes highly important to complement quantitative data with qualitative measures of innovation capability (Chiesa et al.,

1996). Yet until recently innovation research didn't provide comprehensive frameworks for the measurement of innovation capability {Saunila 2012 #278:356}. Practitioners on the contrary have developed some innovation audit and assessment tools into this direction, e.g. the European initiative IMP³prove {European Comission 2012 #280} or the Oslo Manual {Oslo manual 2005 #279}. However a clear view on the relevant qualitative dimensions of innovation performance measurement is still missing, as there is no clear understanding of how different aspects of innovativeness/innovation capability relate to each other {Balachandra 1997 #283:276}(Neely & Hii, 1998){Mallick 2005 #285:144}. Nevertheless key success factors such as leadership, strategy, structure and systems originating from innovativeness/innovation capability research have been denominated as the "foundation for rigorous performance evaluation system for innovation" {Epstein 2007 #282:59}.

Overview on Innovativeness Research

The term innovativeness in literature is used to describe multiple concepts that influence the outcome of innovation activities (Tajeddini & Tajeddini, 2008). First only used to describe and measure innovation adoption by consumers on individual level (Ostlund, 1974; Kirton, 1976; Midgley & Dowling, 1978) the term has been frequently re-conceptualized in different directions. As a consequence, innovativeness nowadays is investigated on individual (Yi, Fiedler, & Park, 2006), group (Liu & Phillips, 2011), organizational (Rubera & Kirca, 2012), regional (Frenkel & Shefer, 1996) and national level (Lee, 1990).

Individual innovativeness first mentioned by Rogers (Rogers, 1962) has evolved into the concept of consumer innovativeness, namely the propensity of a consumer to adopt new products (Hauser, Tellis, & Griffin, 2006). Alongside differences in the understanding of the term, the literature has largely focused on how consumer innovativeness should be measured. Where some

researchers recommend to use hard facts of consumption like products owned, ownership of particular products, purchase intentions or the relative time of adoption for a particular product, others have focused on personality traits, behavioral attitudes or cognitive styles of the consumer itself (Im, Bayus, & Mason, 2003). Aside from conceptualization and operationalization issues, in literature there can't be find a clear picture how consumer innovativeness influences the innovation-firm performance-chain of enterprises.

A second much younger stream, stemming from the combination of Roger's research on individual innovativeness and research on information system applications, elaborates on the construct personal innovativeness. Personal innovativeness represents "the willingness of an individual to try out any new information technology" (Agarwal & Prasad, 1998) and has been largely used as a potential measure to define how organizations should customize their training and support programs for (innovation) employees (Yi et al., 2006).

Another context in which the term innovativeness has been used is research in the area of product innovativeness. In this context innovativeness mainly refers to the degree of newness of an innovation and represents one of the most important descriptors of new products. The term has also been connected to new products' uniqueness, superiority or other aspects that can contribute to competitive advantage. An important contribution to the coherent progress of product innovativeness research comes from Garcia and Calantone (2002), who clarified that product innovativeness depends on the combination of two dimensions, namely the degree of market and technology discontinuity generated by the new product. As a result, a new product should be regarded as radical only if it implies both market and technology discontinuity. Although subsequent research has benefited from a more precise conceptualization, such conceptualization has not been consistently incorporated in the operationalization of product innovativeness, thus

leading to mixed results on the link between product innovativeness and firm performance (Calantone et al., 2006; Szymanski, Kroff, & Troy, 2007).

Firm innovativeness or organizational innovativeness is most often defined as a firm's receptivity and inclination to adopt new ideas that lead to the development and launch of new products (Garcia & Calantone, 2002; Rubera & Kirca, 2012). Given the breadth of firm innovativeness, this stream of research has always been (and still is) characterized by conceptual ambiguity and inconsistent empirical results. Initial contributions in this research stream focused on how characteristics of the organizational structure influence the innovativeness of a project or a firm (Normann, 1971). These studies usually operationalized firm innovativeness through unidimensional measures like the time of adoption or the number of adoptions (Subramanian, 1996). In the following years, as a consequence of the increasing interest in the link between strategic orientations, innovation, and firm performance (Robertson & Wind, 1983; Lumpkin & Dess, 1996), firm innovativeness has been re-conceptualized into "openness to new ideas as an aspect of a firm's culture" (Hurley & Hult, 1998; Gatian, Brown, & Hicks, 1995). However, this understanding of firm innovativeness leads to conceptual overlap with terms like innovation orientation and entrepreneurial orientation (Siguaw, Simpson, & Enz, 2006; Hurley, Hult, & Knight, 2005). In more recent articles (Calantone, Cavusgil, & Zhao, 2002; Das & Joshi, 2012; Ibrahim et al., 2009; Wang & Ahmed, 2004) firm innovativeness has been equated to innovation capability, thus increasing the ambiguity of the term and the difficulties in disentangling the innovativeness-firm performance chain (Woodside, 2005).

The above-mentioned inconsistencies in innovativeness literature generate controversial findings, complicate communication among researchers, and hinder the implementation of effective innovation management practices (Henard & Szymanski, 2001; Garcia & Calantone, 2002; Calantone, Harmancioglu, & Droge, 2010). Thus, the purpose of this study is to clarify the

different nuances of innovativeness, integrate former research in a more conclusive frame of the innovativeness-firm performance chain, and identify which research areas are relevant for the design of innovation performance measurement systems.

METHODOLOGY

The core purpose of bibliometric analysis is "to shed light on the processes of written communication and on the nature and course of development of a discipline" (Pritchard, 1969: 348). In recent years, researchers in innovation management have increasingly accepted bibliometrics as a valuable approach to evaluate and characterize the progress in the field (Biemans, Griffin, & Moenaert, 2007; Durisin et al., 2010; Thieme, 2007; Yang & Tao, 2012). Application of bibliometrics in innovativeness research is of particular value as it is difficult to objectively extrapolate the central findings of the last 50 years 'manually'. In order to reflect progress on the fragmented research field of innovativeness we run citation and co-citation analysis following common and well established methodological instructions (McCain, 1990): (1) determination of the unit of analysis; (2) extraction of articles by citation frequencies (3) retrieval of co-citation frequencies (4) buildup and conversion of raw co-citation matrix into a correlation matrix (5) application of multivariate techniques on correlation matrix and (6) comparison, interpretation and validation of results. Research articles on innovativeness represent the unit of analysis for this study. As a means of identifying topical papers on innovativeness we used Thomson-ISI Web Science databases SSCI and SCI-Expanded to collect data from all relevant business and management categories.[1] In our search we used the term "innovativeness" as a topical limiter to include all articles that use this word as least once in their title, abstract or

[1] After a preanalysis comparison of self-citation increase to total citation increase by adding iteratively categories to the main categories business and management we decided to include all formerly identified categories which might

keywords.[2] Our analysis covers the full time horizon available in the database (from 1945 to 2012).[3] We obtained an initial list of 1059 articles, which after data cleaning resulted in 1056 existing articles with 64902 references.[4] Besides downloading or ordering every article via a library, every reference within the articles was tested for spelling mistakes or erroneous double counts. "InPress" or "Forthcoming" references were inspected for coincidences with references in other articles and when necessary adapted to the real source's name. References showing any kind of similarity in author's name, publication year, journal's name or page number were checked by manual revision. The resulting list of citations was used as input for both citation and co-citation analysis. We first conducted a citation analysis to identify the 100 most cited – and thus most influential - articles on the topic. Past studies already noticed that even if there are thousands of studies in a field, it is most valuable to assess the impact of publications that have been cited heavily over time since these articles "can be considered certified knowledge" (Ramos-Rodríguez & Ruíz-Navarro, 2004) and thus regarded as the foundation of a research field (Samiee & Chabowski, 2012). These most influential articles published between 1969 and 2006 are shown in Table 1.

[2] Besides "innovativeness" we checked also for a fit of the keywords "innovation capability", "innovation ability", "innovation capacity" "innovation orientation" and "organizational innovation" as well as relevant mutations of these words (e.g. innovative capability, capability for innovation, etc.). Single searches by using the first three keywords excluding at the same time contributions which already contained the keyword "innovativeness" yielded in few additional publications. Manual inspection of displayed hits showed that these contributions related most often to different research settings than innovativeness. The search with the key word "organizational innovation" in turn yielded in a much broader contextual spectrum of articles than innovativeness. Therefore to maintain focus on the intellectual structure of innovativeness we didn't include any of these keywords to identify the initial sample of articles under investigation.

[3] Abstract listing in SSCI and SCI Expanded begins from 1992 on, so that articles published before this year can only be identified based on title or keyword.

[4] To minimize potential errors we used additional to manual work whenever possible the common known software BIBEXCEL Persson, Danell, and Schneider (2009); Ramos-Rodríguez and Ruíz-Navarro (2004: 983).

Article	Citations	Article	Citations
Midgley and Dowling (1978)	109	Atuahene-Gima (1996)	33
Cohen and Levinthal (1990)	106	Li and Calantone (1998)	33
Narver and Slater (1990)	104	Moore and Benbasat (1991)	33
Barney (1991)	95	Nahapiet and Ghoshal (1998)	33
Deshpandé et al. (1993)	91	Sinkula (1994)	33
Hurley and Hult (1998)	89	Song and Montoya-Weiss (1998)	33
Jaworski and Kohli (1993)	87	Taylor and Todd (1995)	33
Kohli and Jaworksi (1990)	80	Ajzen (1991)	32
Hirschman (1980)	79	Dewar and Dutton (1986)	32
Davis (1989)	77	Christensen and Bower (1996)	31
Damanpour (1991)	76	Prahalad and Hamel (1990)	31
Goldsmith and Hofacker (1991)	76	Raju (1980)	31
Agarwal and Prasad (1998)	75	Cooper (1979)	30
Slater and Narver (1995)	75	Henderson and Clark (1990)	30
Teece et al. (1997)	73	Ancona and Caldwell (1992)	29
Lumpkin and Dess (1996)	72	Covin and Slevin (1991)	29
Garcia and Calantone (2002)	67	Powell et al. (1996)	29
Davis et al. (1989)	66	Roehrich (2004)	29
Day (1994)	65	Agarwal and Karahanna (2000)	28
Han et al. (1998)	65	Atuahene-Gima (1995)	28
Kleinschmidt and Cooper (1991)	62	Eisenhardt and Martin (2000)	28
Gatignon and Xuereb (1997)	58	Kohli et al. (1993)	28
Olson et al. (1995)	57	Lumpkin and Dess (2001)	28
March (1991)	56	Manning et al. (1995)	28
Covin and Slevin (1989)	55	Nonaka (1994)	28
Wernerfelt (1984)	53	Cooper and Kleinschmidt (1987)	27
Henard and Szymanski (2001)	52	Moorman and Miner (1997)	27
Slater and Narver (1994)	52	Slater and Narver (1998)	27
Danneels and Kleinschmidt (2001)	51	Venkatraman and Price (1990)	27
Steenkamp et al. (1999)	51	Zhou et al. (2005)	27
Hult et al. (2004)	50	Bass (1969)	26
Gatignon and Robertson (1985)	48	Dickerson and Gentry (1983)	26
Kirton (1976)	46	Dougherty (1992)	26
Miller (1983)	45	Eisenhardt and Tabrizi (1995)	26
Hurt et al. (1977)	43	Levinthal and March (1993)	26
Kogut (1992)	42	Narver et al. (2004)	26
Montoya-Weiss and Calantone (1994)	42	Venkatesh and Davis (1996)	26
Venkatesh and Davis (2000)	40	Agarwal and Prasad (1999)	25
Ven van de (1986)	39	Calantone et al. (2006)	25
Venkatesh et al. (2003)	39	Citrin et al. (2000)	25
Brown (1995)	38	Jaffe et al. (1993)	25
Baker (1999)	37	Miller and Friesen (1983)	25
Huber (1991)	37	Ostlund (1974)	25
Im et al. (2003)	36	Parasuraman (2000)	25
Sethi et al. (2001)	36	Hult and Ketchen (2001)	24
Calantone et al. (2002)	34	Mathieson (1991)	24
Grant (1996)	34	Menguc and Auh (2006)	24
Leonard-Barton (1992)	34	Tsai and Ghoshal (1998)	24
Miller and Friesen (1982)	34	Venkatesh (2000)	24
Venkatraman (1989)	34	Wiklund and Shepherd (2005)	24

Table 1: 100 most influential articles on Innovativeness

These 100 most influential articles elaborate on various topics alongside the innovativeness-firm performance chain. Narrowing the attention to the 20 most cited articles, covered topics include the construct of market orientation (Jaworski & Kohli, 1993; Kohli & Jaworski, 1990; Narver &

Slater, 1990) or the connections of of market orientation with other key innovation-related topics like organizational learning (Cohen & Levinthal, 1990; Slater & Narver, 1995). Next to this firm-level research a handful of articles elaborate on individual level research on innovativeness, including consumer innovativeness (Goldsmith & Hofacker, 1991; Hirschman, 1980; Midgley & Dowling, 1978) or personal innovativeness (Agarwal & Prasad, 1998; Davis, 1989). Furthermore some publications refer to basic underlying theories of innovation management, like the dynamic capability (Teece, Pisano, & Shuen, 1997) or resource-based view (Barney, 1991). Besides articles focusing on special topics within the innovativeness-firm performance chain, there is also a group of authors investigating the whole chain relation between innovation culture, innovation output and firm performance (Deshpande, Farley, & Webster, 1993; Hurley & Hult, 1998). From an innovation output perspective, articles deal with both administrative (Damanpour, 1991) and product innovativeness (Garcia & Calantone, 2002). Finally, one article attempts to ground the construct of entrepreneurial orientation and its relationship with innovativeness (Lumpkin & Dess, 2001).

Although these 100 most cited articles represent less than 10 % of the articles in the domain of innovativeness, they count for more than 83 % of the total number of citations. This high percentage of citation coverage suggests that the origins and foundations of research on innovativeness are accurately and largely captured (McCain, 1990). As third step of our bibliometric study we performed a co-citation analysis of the 100 most cited articles. Thus, we organized these articles in a 100 x 100 symmetrical square matrix reporting how often each pair of articles has been cited together in a third article of the sample (Ramos-Rodríguez & Ruíz-Navarro, 2004). The raw co-citation matrix was subsequently converted into a Pearson correlation matrix. Compared to raw co-citations the Pearson correlation coefficients normalize the data and account not only for the total number of co-citations but also for the similarity of the

profile of two articles (Rowlands, 1999). Thus, the Pearson correlation coefficient is a measure of similarity for the co-citation profile of two references across a population of articles. The obtained correlation matrix was used as input for the multivariate techniques supporting bibliometric analysis (McCain, 1990).

THE STRUCTURE OF THE MOST INFLUENTIAL PUBLICATIONS IN INNOVATIVENESS RESEARCH

We used exploratory factor analysis [EFA], hierarchical cluster analysis [HCA] and multidimensional scaling [MDS] to unfold the intellectual structure of research on innovativeness, as depicted by the 100 most cited publications. The application of different methods permits an evaluation of results' stability and a comparison across methods for achieving more nuanced knowledge (Samiee & Chabowski, 2012). For facilitating comparison, results of all three techniques are represented in an identical two-dimensional space that was created through the MDS approach. Proximities of articles are especially useful in MDS, to identify influential paradigms and to deduct emerging paradigms. Even though the model stress can be reduced to an optimal level by adding more dimensions to the screen, we decided to follow the praxis in bibliometric articles and use only two dimensions, thus keeping interpretability as high as possible (Hair, 2010).

Exploratory factor analysis

EFA is used to explain the interrelationships observed among articles through derivation of a smaller number of factors. By qualitative observation and denomination of the resulting factors it is possible to reveal the hidden subject which citers associate with a bundle of articles (McCain, 1990). For the extraction of factors we used principal component analysis, which represents the most common method. To determine the number of extracted factors we applied Kaiser Criterion

combined with an inspection of the scree plot. After factor rotation with the varimax algorithm we obtained 7 factors all with a final eigenvalue higher than 3,00[5], which explain 83,9 % of the variance. All articles have at least one factor on which their loading is higher than 0,5. As recommended in past literature we use superscripts to indicate articles' secondary and third loadings higher than 0,4 (Di Stefano, Gambardella, & Verona, 2012). Cross-loadings of individual articles in this context can indicate that the article tries to bridge different perspectives. Results from EFA are shown analytically in Table 2 and graphically in Figure 1.

[5] There are 8 factors with an eigenvalue higher than 1,00. Scree plot recommends seven factors as from factor 8 on their can be identified a clear linear function between eigenvalue and number of factors. Given that factor 8 has an eigenvalue slightly above 1,00 and the explained variances even after rotation only increases by 1,6 % we ultimately decided to reduce the number of extracted factors to 7. When looking on rotated factor configurations only insignificant differences between the 7-factor- and 8-factor-solution could be detected.

No	Article	F1	F2	F3	No	Article	F3	F4	F5	F6	F7
1	Slater and Narver (1994)	,910			51	Jaffe at al. (1993)	,800				
2	Han et al. (1998)	,909			52	Grant (1996)[1]	,795				
3	Slater and Narver (1998)	,906			53	Eisenhardt and Martin (2000)	,788				
4	Kohli et al. (1993)	,890			54	Nahapiet and Ghoshal (1998)	,783				
5	Menguc and Auh (2006)	,890			55	Tsai and Ghoshal (1998)	,739				
6	Christensen and Bower (1996)	,888			56	Teece et al. (1997)[1]	,702				
7	Hult and Ketchen (2001)	,887			57	Leonard-Barton (1992)	,672				
8	Jaworski and Kohli (1993)	,887			58	Henderson and Clark (1990)[5]	,642				
9	Atuahene-Gima (1996)	,886			59	March (1991)[1]	,641				
10	Deshpandè et al. (1993)	,884			60	Cohen and Levinthal (1990)[1]	,636				
11	Kohli and Jaworski (1990)	,883			61	Dewar and Dutton (1986)[7]	,586				
12	Day (1994)	,876			62	Levinthal and March (1993)[1]	,542				
13	Narver et al. (2004)	,874			63	Agarwal and Prasad (1999)		,925			
14	Baker (1999)	,868			64	Mathieson (1991)		,924			
15	Hurley and Hult (1998)	,857			65	Venkatesh (2000)		,924			
16	Slater and Narver (1995)	,855			66	Venkatesh et al. (2003)		,914			
17	Narver and Slater (1990)	,849			67	Venkatesh and Davis (2000)		,913			
18	Sinkula (1994)	,846			68	Venkatesh and Davis (1996)		,910			
19	Hult et al. (2004)	,786			69	Moore and Benbasat (1991)		,896			
20	Gatignon and Xuereb (1997)[5]	,753			70	Taylor and Todd (1995)		,895			
21	Calantone et al. (2002)[3]	,750			71	Agarwal and Karahanna (2000)		,878			
22	Damanpour (1991)	,728			72	Ajzen (1991)		,852			
23	Li and Calantone (1998)[5]	,679			73	Davis et al. (1989)		,845			
24	Ven van de (1986)[3]	,639			74	Agarwal and Prasad (1998)		,838			
25	Huber (1991)[3]	,637			75	Davis (1989)		,818			
26	Wernerfelt (1984)[3]	,627			76	Song and Montoya-Weiss (1998)			,865		
27	Barney (1991)[3]	,583			77	Cooper (1979)			,849		
28	Moorman and Miner (1997)[3,7]	,523			78	Cooper and Kleinschmidt (1987)			,837		
29	Zhou et al. (2005)[5,6]	,526			79	Danneels and Kleinschmidt (2001)			,837		
30	Roehrich (2004)		,936		80	Calantone et al. (2006)			,833		
31	Manning et al. (1995)		,929		81	Kleinschmidt and Cooper (1991)			,820		
32	Venkatraman and Price (1990)		,924		82	Montoya-Weiss and Calantone			,798		
33	Dickerson and Gentry (1983)		,917		83	Henard and Szymanski (2001)[1]			,788		
34	Gatignon and Robertson (1985)		,915		84	Atuahene-Gima (1995)[1]			,732		
35	Raju (1980)		,915		85	Garcia and Calantone (2002)			,730		
36	Im et al. (2003)		,911		86	Olson et al. (1995)[1]			,643		
37	Steenkamp et al. (1999)		,911		87	Brown (1995)[3,7]			,514		
38	Bass (1969)		,902		88	Wiklund and Shepherd (2005)				,938	
39	Ostlund (1974)		,873		89	Covin and Slevin (1991)				,924	
40	Kirton (1976)		,841		90	Lumpkin and Dess (2001)				,923	
41	Citrin et al. (2000)		,838		91	Miller and Friesen (1982)				,873	
42	Goldsmith and Hofacker (1991)		,834		92	Miller and Friesen (1983)				,858	
43	Hirschman (1980)		,825		93	Miller (1983)				,829	
44	Hurt et al. (1977)		,807		94	Venkatraman (1989)				,822	
45	Midgley and Dowling (1978)		,728		95	Covin and Slevin (1989)				,797	
46	Parasuraman (2000)[4]		,665		96	Lumpkin and Dess (1996)[1]				,737	
47	Kogut (1992)			,863	97	Ancona and Caldwell (1992)					,735
48	Nonaka (1994)			,859	98	Dougherty (1992)					,723
49	Prahalad and Hamel (1990)			,852	99	Sethi et al. (2001)[5]					,568
50	Powell et al. (1996)			,848	100	Eisenhardt and Tabrizi (1995)[3,5]					,533

Factor 1: Market Orientation [MO]; Factor 2: Consumer Innovativeness [CI]; Factor 3: Knowledge & Learning [Kn & Le]; Factor 4: Personal Innovativeness [PeI]; Factor 5: Product Innovativeness [PrI]; Factor 6: Entrepreneurial Orientation [EO]; Factor 7: Team Dynamics [TD]

Table 2: Factor analysis of the 100 most influential articles on innovativeness [EFA]

For the interpretation of the factors we investigated the abstract and (when needed) the content of all articles belonging to a certain factor to look for common themes. A quick overview of the

factors highlights the breadth of research domains associated with 'innovativeness', confirming the fragmented and complex nature of the topic. However, a closer look at each factor provides a first glimpse on the underlying intellectual structure. Factor 1 groups the highest number of articles and counts for 22,7 % of the variance after rotation. Articles belonging to this factor focus mainly on market orientation, including its different conceptualizations and operationalizations, its influence on innovation performance, and its relation to other (sometimes overlapping) concepts like firm innovativeness, organizational innovation or organizational learning. More recent articles have approached market orientation using a resource-based view (RBV) perspective (Hurley & Hult, 1998). Accordingly, market orientation, if appropriately combined with other capabilities like organization learning, can contribute to the creation of unique resources for achieving competitive advantage through innovation. This perspective might explain the presence of foundational articles on RBV (Barney, 1991; Wernerfelt, 1984) and the six articles' cross-loadings to the factor 'knowledge and learning' (Factor 3). Furthermore, three articles cross-load on product innovativeness (Factor 5) providing evidence of the widespread view of market orientation as an antecedent of product innovativeness.

Factor 2 (14,75 % of variance) binds articles on consumer innovativeness and its role in market adoption of new products or services. Thus, articles in this group include both articles defining and operationalizing consumer innovativeness and seminal articles on innovation diffusion models (Bass, 1969; Gatignon & Robertson, 1985; Ostlund, 1974). As it happens for other factors, the presence of only one cross-loading indicates that consumer innovativeness is a well-defined, theoretically grounded, and mature area of research.

Factor 3 (12,78 % of variance) compounds mainly conceptual articles on the theoretical foundations of innovations, including the knowledge based view of the firm (KBV), and the

learning processes and the set of competences and capabilities for pursuing successful innovation, and the learning processes for acquiring and maintaining such capabilities.

Factor 4 (12,6 % of variance) groups articles investigating managers' acceptance and use of information technologies, according to either the technology acceptance model (TAM) (Davis, Bagozzi, & Warshaw, 1989) or the theory of planned behavior (Ajzen, 1991). This research stream is based on the assumption that, although information technologies can improve organizational performance, their novelty and impact on organizational routines might generate resistance to their adoption. The topic was initially studied within the information system literature, but it has progressively become an issue of interest for innovativeness research in general.

The articles loading on Factor 5 (10,0 % of variance) focus on the new product development (NPD) process, and investigate NPD success factors in general and product innovativeness in particular. Most of the articles in this group elaborate on the conceptualization and operationalization of product innovativeness, and on its relationship with different measures of innovation performance. The presence of several cross-loadings with other factors reflects the frequency with which this core concept has been incorporated (sometimes inconsistently) in innovation frameworks of different nature.

Factor 6 (7,9 % of variance) aggregates articles on entrepreneurial orientation, which is regarded as an effective strategic orientation in turbulent competitive environments.

Finally, Factor 7 (3,2 % of variance) includes articles on the role, composition and management of innovation teams. Two cross-loads on product innovativeness and one cross-load on knowledge and capabilities reveal how this apparently young research stream plays a bridging role to other established research streams.

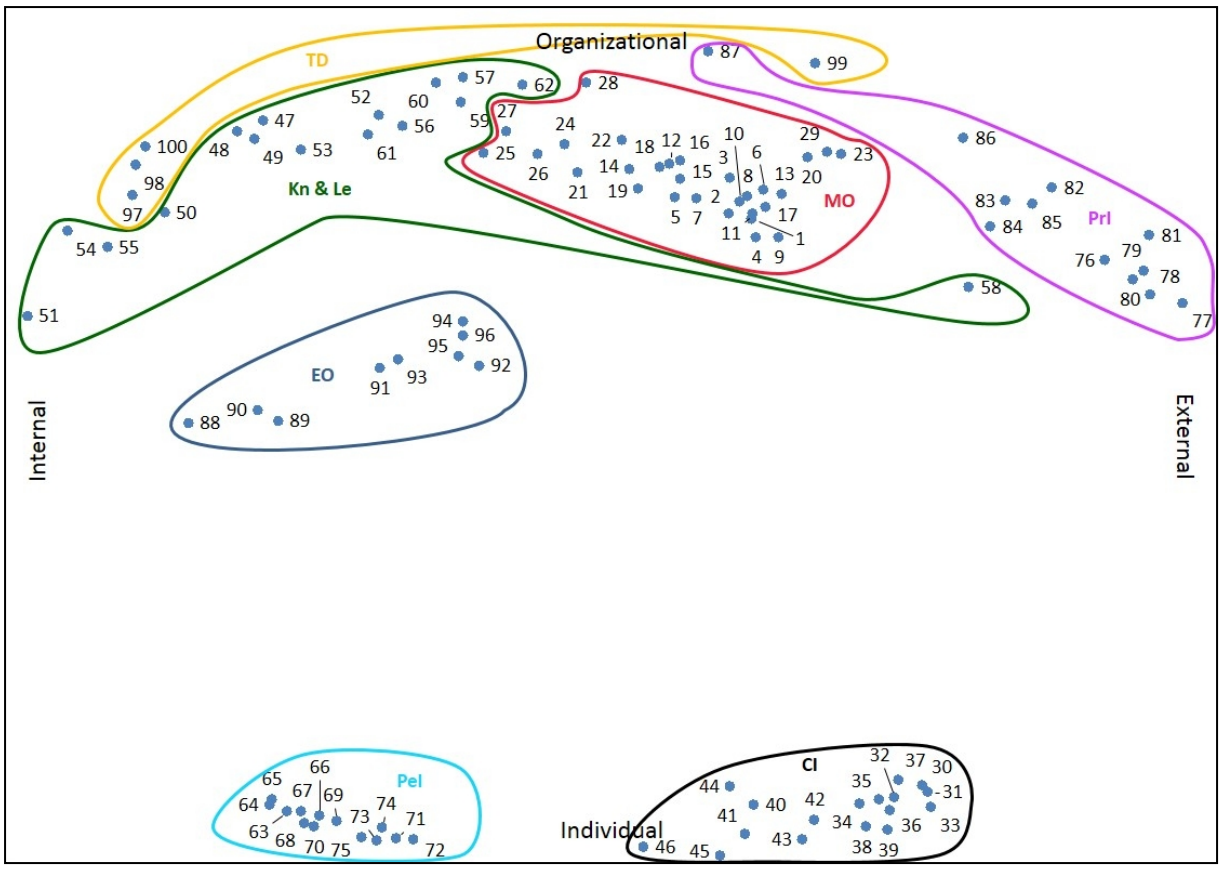


Figure 1: Graphical representation of exploratory factor analysis [EFA]

The seven factors are plotted in Figure 1, using 'internal/external perspective' as horizontal dimension and the 'level of analysis' as vertical dimension. The 'internal/external perspective' indicates the extent to which research focuses on innovativeness as depending on firm resources and capabilities (internal perspective), or on the characteristic of the innovation outcome and its fit with the market (external perspective). The vertical dimension captures the level of analysis adopted in different research streams on innovativeness. Specifically, researchers investigated innovativeness as a personal characteristic affecting the individual willingness to adopt new products and/or technologies (individual level of analysis) and as an organizational capability affecting companies' processes and products.

While Figure 1 reflects the factors in Table 2 quite accurately, some inconsistencies are worth to mention. As to the article by Henderson and Clark (1990) (article 58), while it loads on the

'Knowledge and Capabilities' factor, its closeness to product innovativeness (and its cross-loading on product innovativeness) analyses can be explained by the fact that the article looks at how a company's knowledge structure is reflected in the architecture and features of its new products. Similarly, Sethi, Smith and Park (2001) (article 99) study how differences in teams' characteristics can influence the degree of product innovativeness, thus, explaining the closeness to and cross-loading on product innovativeness.

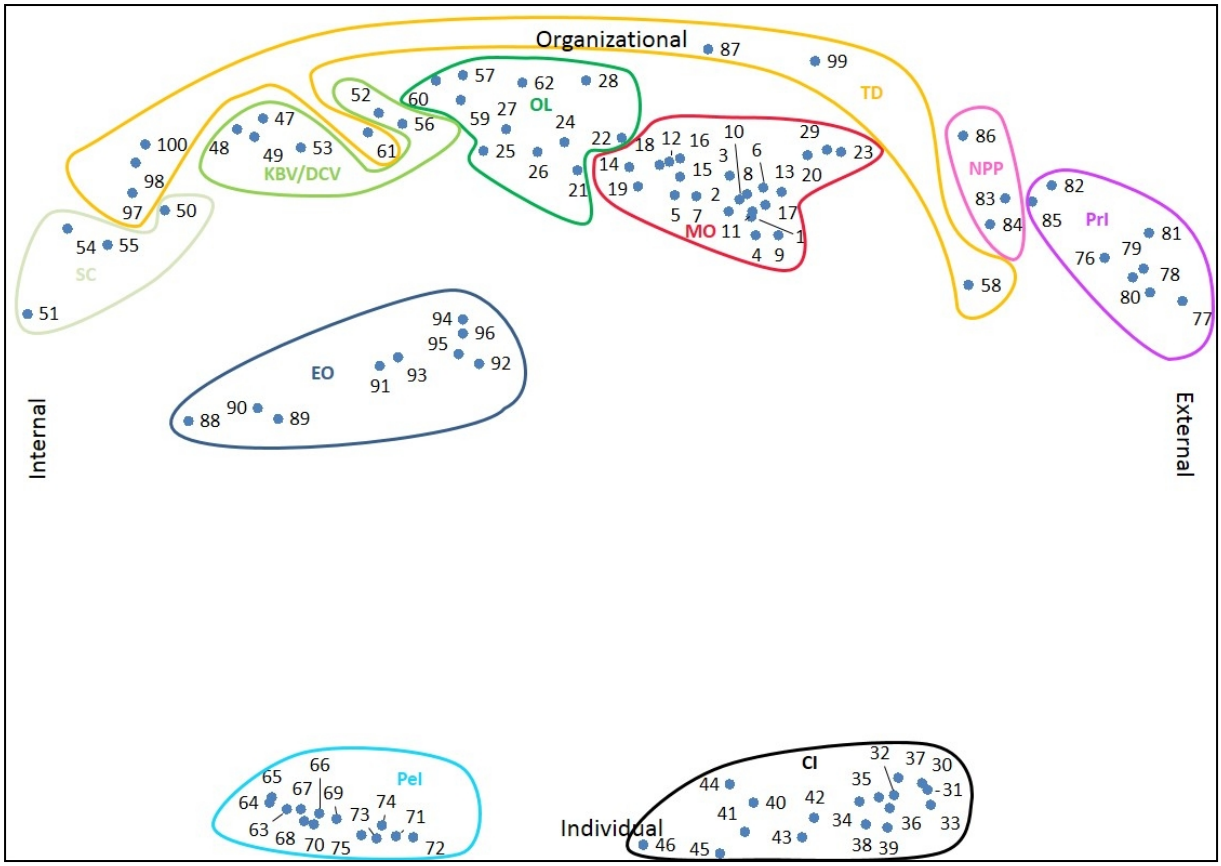
Hierarchical cluster analysis

To reflect critically or potentially detail results from EFA we conducted a hierarchical cluster analysis. We chose complete-linkage algorithm as fusion method. To determine an optimal number of clusters we used the obtained dendrogram and a manually built scree plot (McCain, 1990).[6] HCA yielded in 10 clusters. Again for the denomination of the clusters we inspected every single article looking for similarities. Figure 2 reports the results of HCA.

In comparison to EFA hierarchical cluster analysis leads to a more nuanced solution. The research clusters on entrepreneurial orientation, consumer innovativeness and personal innovativeness remain unchanged. Market orientation and product innovativeness contain fewer articles, thus becoming more focused on their respective core theme. A small new product performance cluster originated from the former product innovativeness group, focusing on articles investigating the link between product innovativeness and product performance. The research cluster on knowledge and learning has split in three subgroups – i.e., social capital, knowledge and capabilities, and organizational learning. The cluster on social capital combines articles on the role of networks of relationships in creating and transferring knowledge (Nahapiet

[6] Screeplot shows a linear function either after 10 or after 14 clusters. Dendrogram offers like a maximum 10 clusters. To maintain transparency and interpretability we decided to take the solution with 10 clusters.

& Ghoshal, 1998). The knowledge and capabilities cluster contains the foundational conceptual articles on the knowledge based view of the firm and dynamic capabilities. The organizational learning cluster groups mostly articles on the concept of learning orientation. The team dynamics factor now represents a cluster with seven articles indicating that much more investigations are relevant to this sub research area.



CI: Consumer innovativeness; EO: Entrepreneurial orientation; KBV/DCV: Knowledge-based and dynamic capability view; MO: Market Orientation; NPP: New product performance; OL: Organizational learning; PeI: Personal innovativeness; PrI: Product Innovativeness; SC: Social Capital; TD: Team dynamics

Figure 2: Graphical representation of hierarchical cluster analysis [HCA]

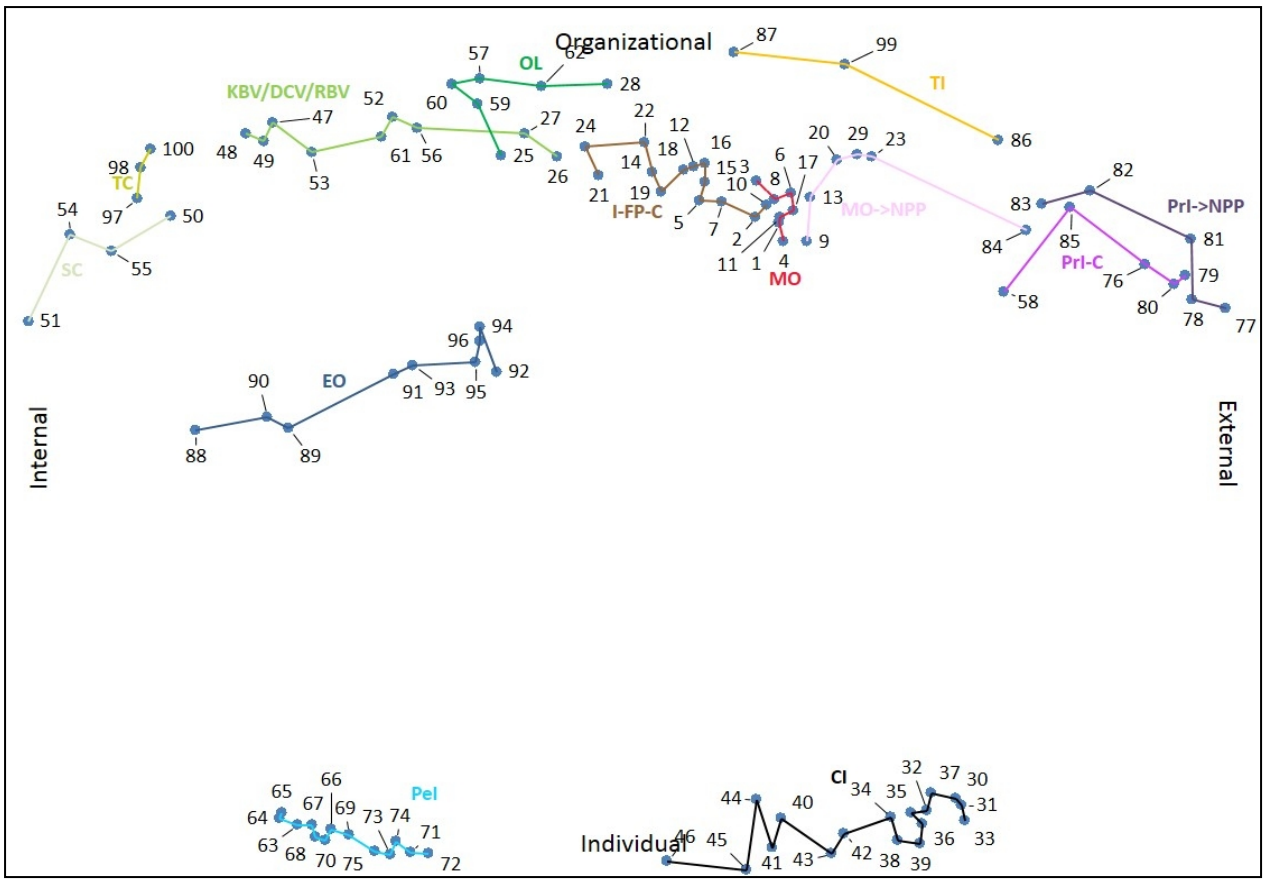
Multidimensional scaling

As a third method multidimensional scaling was used. Given that MDS only produces a graphical configuration of the objects under investigation this method brings the highest degree of flexibility in interpretation (Samiee & Chabowski, 2012). Stress-1 and Stress-2 values were 0,17

respectively 0,33 and represent an accurate data fit (Ramos-Rodríguez & Ruíz-Navarro, 2004). Groups in the MDS chart were built manually, through the content analysis of every article for identifying topical differences and trying to solve inconsistencies of the EFA and HCA solutions. Results from MDS are shown in Figure 3.

This process led to the extraction of 13 meaningful groups. In comparison to HCA the team dynamics cluster is split up into groups, namely team composition and team interaction. Whereas team composition focuses on creating the optimal combination of team members based on team design parameters, team interaction incorporates the interplay of the innovation team with suppliers, customers and other external partners. The knowledge and capability cluster is extended by including two theoretical articles on the resource-based view of the firm. As a result, this cluster now thoroughly groups the theoretical foundation of organizational research in innovativeness/innovation. From both market orientation and organizational learning clusters we derived a third group, i.e., innovation-firm performance chain. This group captures articles analyzing multiple antecedents of innovativeness, and their synergies in affecting innovativeness and firm performance. For instance some empirical articles investigate how antecedents like market, learning or entrepreneurial orientation are intertwined and how their combined effect influences innovation culture, innovation output or firm performance.

In comparison to HCA the organizational learning group is more focused and elaborates on the concept of how organizations can learn from new acquired knowledge. The articles contained possess a strongly conceptual nature. A new group which mostly originates from the market orientation cluster investigates the connection between market orientation and new product performance. The product innovativeness cluster is divided in one group which focuses more on the concept of product innovativeness and in another group which investigates the impact of product innovativeness on new product performance.



CI: Consumer innovativeness; EO: Entrepreneurial orientation; I-FP-C: Innovation-Firm performance chain ; KBV/DCV/RBV: Knowledge-based, dynamic capability and resource based view; MO: Market Orientation; MO->NPP: Market orientation new product performance linkage; OL: Organizational learning; PeI: Personal innovativeness; PrI-C: Product innovativeness, conceptualization; PrI->NPP: Product Innovativeness new product performance linkage; SC: Social Capital; TC: Team composition; TI: Team Interaction

Figure 3: Graphical representation of multidimensional scaling [MDS]

Multi-method comparison

EFA, HCA and MDS reveal somewhat different configurations of the 100 most influential articles on innovativeness research. A cross-method comparison (see Figure 4) provides insights on how each method contributes to identify research subfields in innovativeness. EFA generates an initial overview of key topics in the area of interest. Nevertheless the large amount of cross-loadings indicates that the obtained seven factors need further analysis. HCA acts in this direction by providing a much clearer picture of research on innovativeness, especially with reference to the topic of knowledge. MDS opens the possibility to ground the market orientation and

innovation-firm performance chain group. In many of the publications on the innovation-firm performance chain market orientation is seen as a (cultural) antecedent of firm innovativeness.

By looking on all three configuration simultaneously there can be easily notified that research subfields on the individual level stay stable across all three configurations whereas articles on the firm level seem to contribute much more on several nuanced research subfields. In general it can be derived that all three methods lead to meaningful overviews and the results get more detailed from EFA to HCA to MDS.

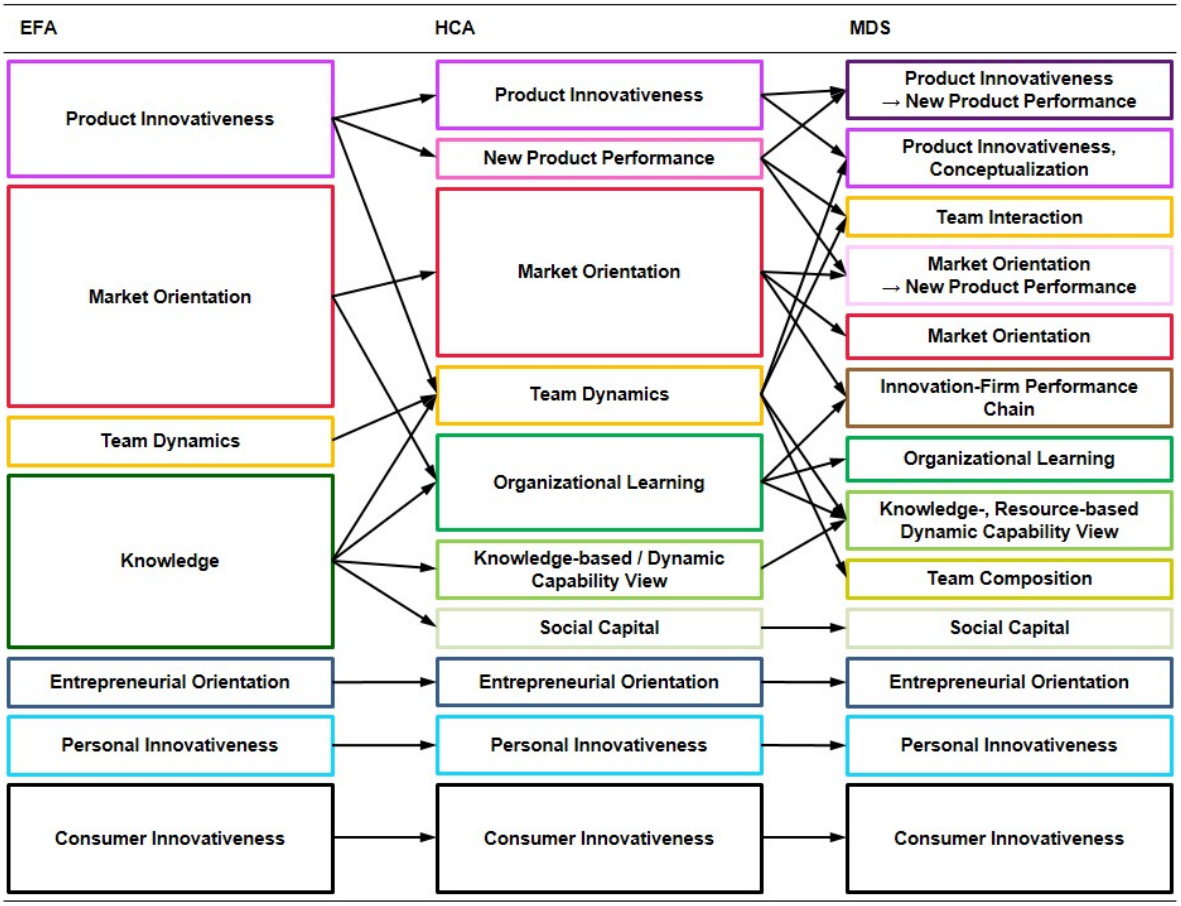


Figure 4: Comparison of EFA, HCA and MDS configurations of innovativeness research knowledge structure

DISCUSSION

Research on the notion of innovativeness is a wide field of investigation, which tries to identify companies' capabilities relevant to innovation success and, thus, to disentangle the innovation-

firm performance chain. As a result, innovativeness has been interpreted in multiple ways. One leading question of this study was the identification of the meanings that can be considered well established. In this regard the objective procedure of bibliometric analysis confirms that four types of innovativeness exhibit a longer tradition in literature, namely personal innovativeness and consumer innovativeness at the individual level, and product innovativeness and firm innovativeness at an organizational level. Additionally, bibliometric objective criteria of number of citations and co-citations have allowed us to indicate the key references within each typology and, thus, to clearly mark the boundaries of these four subfields of innovativeness research. The adoption of the typologies (definitions, main references, and conceptual boundaries) emerged from our bibliometric analysis could facilitate a more coherent development of the field and, possibly, more conclusive results on cause-effect relationships in the innovation-firm performance chain.

Our bibliometric analysis also points to the fact that indeed a clear understanding of the cause-effect relationships remains a challenge for the field. Figure 5 summarizes the topics emerged from the analysis and how they relate to each other. The relationships (arrows in Figure 5) are based on how the connections across core topics have been theoretically derived and empirically tested in the most cited articles.

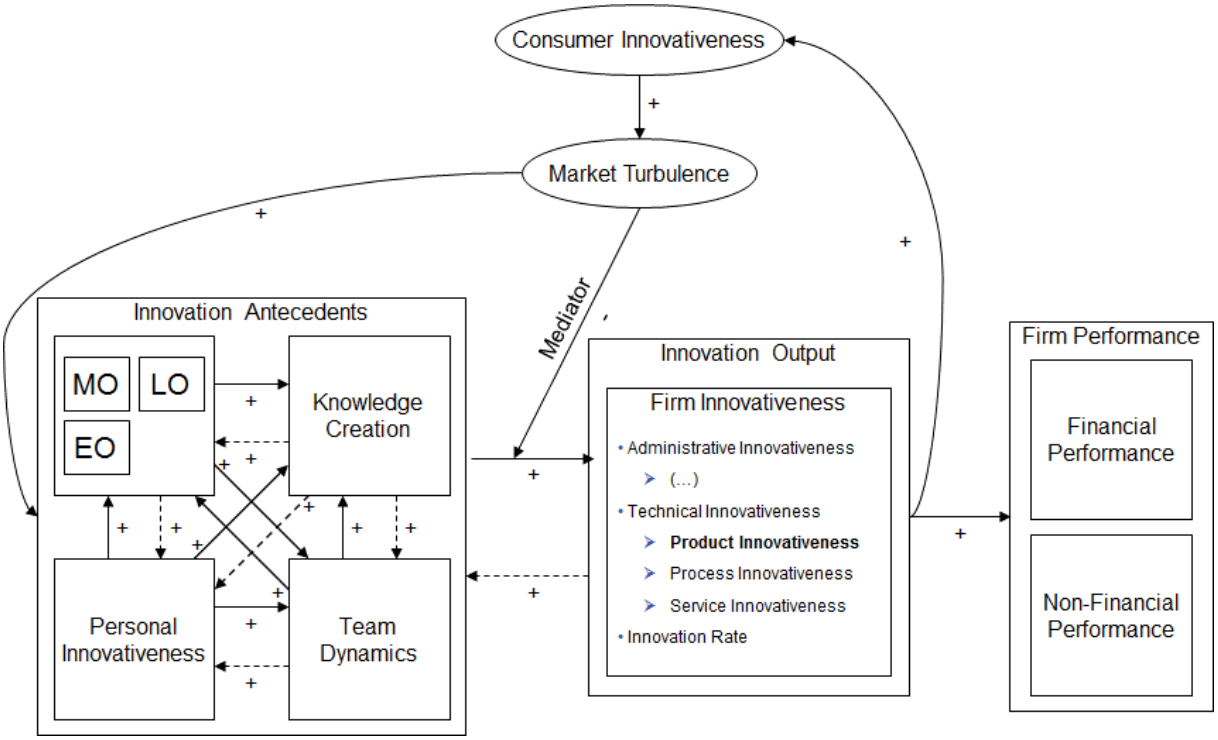


Figure 5: System dynamics view on the innovation-firm performance chain

As emphasized by the arrows in Figure 5, literature has not reached agreement on the directionality of the relationships among innovation capability's components, and between innovation capability and firm innovativeness (its outcome). This is consistent with the emerging perspective according to which a system dynamics view (instead of a one-directional view) offers a better explanation of innovation capability and its role in innovation (and firm) performance (Woodside, 2005). Accordingly, in a system dynamics model all variables have both cause and effect relationships with other variables in the system, in a continuous loop of both positive and negative feedback (Luna-Reyes & Andersen, 2003; Sterman, 2000). Empirical research on innovativeness has mainly focused on one-directional frameworks, where the innovation-related resources and capabilities are regarded as antecedents of firm innovativeness and innovation performance. An interesting direction for future research could be the empirical corroboration of

a system dynamics view of innovation capability, by using both qualitative and quantitative methodologies that support multi-directional frameworks.

Additionally, our analysis suggests that innovation capability consists of the combination and interaction of certain firm capabilities (MO, EO, OL) and certain key resources (personal innovativeness, knowledge base, team dynamics). Although each component of innovation capability is well developed as a separate field of research, none has emerged as a superior and thorough explanation of how to achieve innovation and, consequently, sustainable competitive advantage. As a result, an interesting research direction is the investigation of synergies and incompatibilities across these fields of research, in order to find optimal combinations of orientations/cultures and resources for achieving higher innovativeness and, thus, improve firm performance (Baker & Sinkula, 1999; Hauser, Tellis, & Griffin, 2006; Paladino, 2008).

Figure 5 includes one exogenous variable, i.e. consumer innovativeness. Consistently with other literature reviews (Hauser et al., 2006), consumer innovativeness emerges as a well-consolidated area of research (high number of articles in this cluster, most cited article belongs to this cluster, clear cluster in MDS).

Research on consumer innovativeness focuses on individual behaviour and measures, with limited consideration for the aggregate outcomes. Given that the high failure rate of innovation is often ascribed to innovators' deficiencies in understanding consumers' needs and behaviour (Barczak, Griffin, & Kahn, 2009), the relationship between aggregate measures of consumer innovativeness and other innovation capability topics is an important area for future research. Efforts in this direction include the frequent inclusion of market turbulence as an aggregate proxy for consumer innovativeness. Market turbulence is defined as the continuous change in the composition and preferences of consumers in a given market (Slater and Narver, 1994). Market turbulence has been frequently regarded as a contingency factor in empirical studies investigating

the relationship between innovation capabilities/orientation and innovation outcome (Calantone, Garcia, & Droge, 2003; Han, Kim, & Srivastava, 1998; Paladino, 2008).

Deduction of an Innovation Performance Measurement Framework

Though our findings provide clarity in terminology, definitions and boundaries, innovativeness/innovation capability remains a complex phenomenon. Innovation performance measurement systems [IPMS] not able to capture such complexity might lead to an inappropriate base for decision-making (Kerssens-van Drongelen & Cooke, 1997). There are many IPMS currently available to practitioners (e.g. Diamond Model, Innovation Funnel, Innovation Value Chain, OSLO Manual Innovation Measurement Framework, InnoCERT, Inno-Biz assessment, NESTA, IMP³prove, Innovation radar or Innovation for Growth). However, there are only few scientific studies attempting to provide guidelines for developing a comprehensive and integrated IPMS. In this part of the article we use the results of our bibliometric analysis for building a framework for developing an effective IPMS based on key past findings in innovation management research. When building up our framework we follow the widespread credo that there is no single measure that is adequate for innovation control (Griffin & Page, 1996). Furthermore we take different measurement methods (e.g. subjective vs. objective, quantitative vs. qualitative, financial vs. non-financial) as a basis for capturing different aspects in the innovation-firm performance chain (Kerssens-van Drongelen et al., 2000). The resulting innovation performance measurement framework is shown in Figure 6. Terms not directly extracted from bibliometric analysis have been put in parentheses.

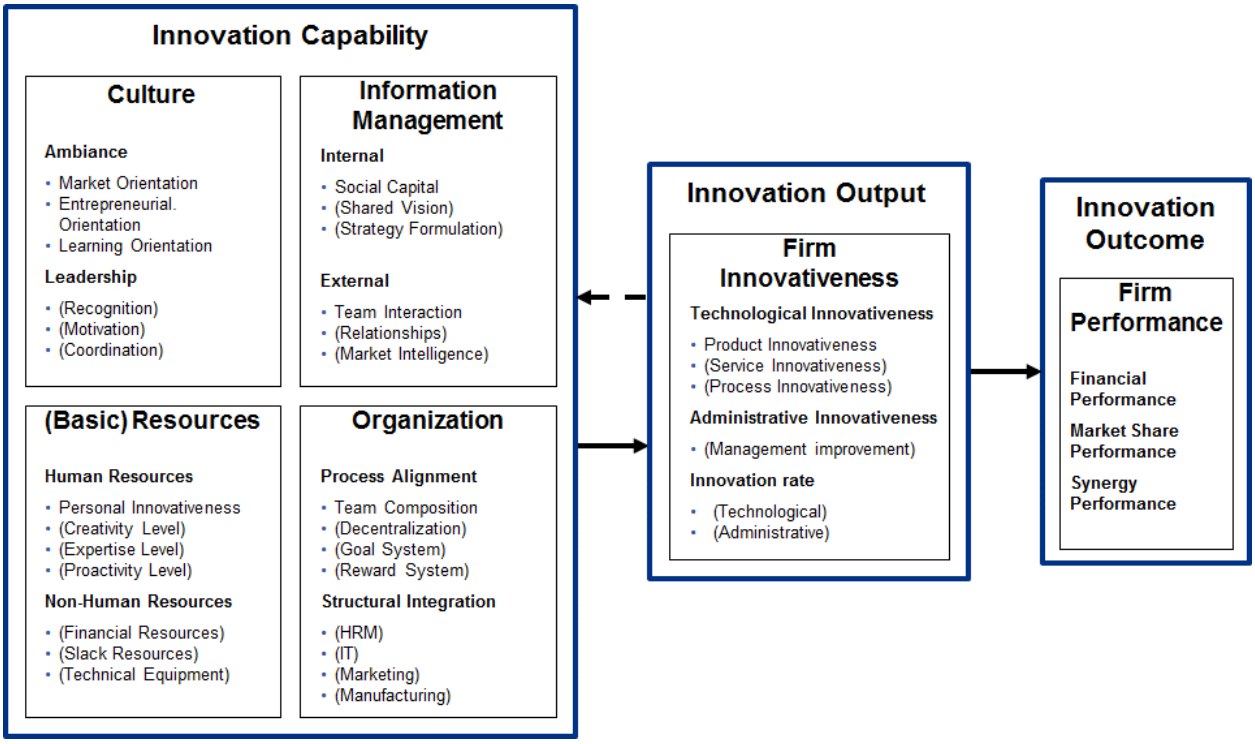


Figure 6: Innovation performance measurement framework derived from literature review and bibliometric analysis

Whereas previous innovation performance management frameworks propose to differentiate between inputs, process, output and outcome measures (Brown & Svenson, 1998), we sum up the first two as innovation capability. Innovation capability has been understood as a higher-order integration capability where consolidated capabilities might complement each other (Lawson & Samson, 2001). In this regard it has already be shown that a larger availability of classical inputs like expenses or employees does not necessarily lead to a better innovation performance (Chiesa & Frattini, 2009), but rather the interplay with other success factors leads to an advantage. Although culture and basic resources from a technical perspective might be seen as the inputs and information management as well as organization might represent the process, we do not recommend to derive measures for these categories separately. All four categories are strongly intertwined and individual treatment leads easily to exclusion of important interdependencies in the measurement system. In contrast, a clear differentiation of innovation capability, output and

outcome reduces the probability of obtaining tautological results. To cover innovation output holistically we conceptualize firm innovativeness beyond product innovativeness. Besides the indispensable evaluation of the technological innovativeness and administrative innovativeness of a firm, also the rate or speed of innovation adoption should be implicated. Firm performance can be seen as the aggregated form of innovation outcome. Besides the often already incorporated financial performance, firm performance should also include non-financial dimensions of innovation outcome, like market share or synergy performance. Especially the latter kind of performance enables innovation control to put also some emphasis on the impact of administrative innovations which often yield in internal non-monetary improvements.

LIMITATIONS AND CONCLUSIONS

One of the main criticism of citation analysis is that citations do not always adequately reflect the intellectual structure of a field (Biemans et al., 2007). However, this study addresses the issue by using also co-citation frequencies, generating similarity profiles of the most cited articles and displaying them by means of multivariate techniques in graphical configurations. Furthermore the obtained objective results in the bibliometric perspective are critically questioned by qualitative findings through a literature review. Another limitation comes along with the identification of relevant articles – publications that do not use the term innovativeness in title, abstract or as a keyword have not been included in the initial sample even though they might be highly relevant to the topic. To include as many as possible of these unobvious contextual contributions the identification of the hundred most cited articles was not limited to the initial sample.

Despite such limitations, our study generates some relevant results. Innovativeness remains an extensive field of investigation within the innovation-firm performance chain. The bibliometric approach of this study revealed that especially the sub-fields of personal innovativeness and

consumer innovativeness as behavioral patterns as well as product innovativeness as form of innovation output represent well-established types of innovativeness. The disagreement on the conceptual definition of firm innovativeness was also shown through the bibliometric analysis as no firm innovativeness group could be identified in any of the solutions offered by the multivariate techniques. The younger denominations of innovativeness as a firm's innovation capability or innovation culture entails the risk that research gets massively hampered by using the same term for completely different aspects in the innovation-firm performance chain. To increase coherence and transparency of innovativeness research, it is therefore recommended that future studies use the terms innovation capability, innovation culture or innovation orientation instead of the already over-exploited notion of innovativeness. Furthermore the obtained graphical maps and the number of cross-loadings within the bibliometric analysis indicate that innovativeness research on individual level, namely consumer innovativeness and personal innovativeness, is not connected to the innovativeness types on organizational level. The emerging system dynamics view – hence the consideration of multidirectional flows in innovation-firm performance chain research – corroborates that innovation performance measurement in the past might have been too narrow and excluded important interdependencies.

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