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RAISING INNOVATIVENESS THROUGH ADOPTION AND USE OF ORGANIZATIONAL PRACTICES AND PROCESS TECHNOLOGIES

Rita Faullant
University of Southern Denmark & Alpen-Adria University Klagenfurt
Centre for Integrative Innovation Management
Rita.Faullant@aau.at

Mette Praest Knudsen
SDU
Department of Marketing & Management
mpk@sam.sdu.dk

Abstract

A core challenge for firms is accordingly not only to become innovative, but also to strengthen the innovative capabilities over time to remain innovative or even increase innovativeness. National statistics repeatedly report that a significant portion of firms across Europe are not innovative and hence jeopardize their own future competitiveness. This study investigates how the adoption and extent of use of distinct organizational practices and production technologies discriminate between firms that are not innovative, innovative and radically innovative. Based on survey data for Danish manufacturing firms, the paper finds that to change from being non-innovative to incrementally innovative firms can benefit from adopting process technologies like e.g. rapid prototyping, whereas the further change from incremental innovative to become radically innovative requires implementation of organizational innovations like e.g. cross-functional teams and collective arrangements for flexible working hours. The process technologies are not significant in inducing this additional increase in innovative performance. Therefore, the managerial challenge for strengthening the innovative capabilities of the firm depends strongly on the current abilities of the firm as expressed in its innovative forms.

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ABSTRACT

A core challenge for firms is not only to become innovative, but also to strengthen the innovative capabilities over time to remain innovative or even increase innovativeness. However, statistics repeatedly report that a significant portion of firms across Europe are not innovative and hence jeopardize their own future competitiveness. This study investigates how the adoption and extent of use of distinct organizational practices and production technologies discriminate between firms that are not innovative, innovative and radically innovative. Based on survey data for Danish manufacturing firms, the paper finds that to change from being non-innovative to incrementally innovative firms can benefit from adopting process technologies like e.g. rapid prototyping, whereas the further change from incremental innovative to become radically innovative requires implementation of organizational innovations like e.g. regular individual appraisal interviews, wage systems with team performance incentives, and arrangements for flexible working hours. The process technologies are not significant in inducing this additional increase in innovative performance. The paper discusses the apparent contradictory results where our study highlights the importance of organizational innovation practices, whereas the process innovative technologies are of limited importance.

Keywords: Radical product innovation, incremental innovation, process innovation, organizational innovation, innovation performance.

1. INTRODUCTION

Despite the strong voice by research as to the importance of innovation as a driver of the future competitiveness of firms and nations, the national statistics repeatedly report either stagnating or even decreasing innovativeness of firms. Further, a significant share of firms across Europe is not innovative and hence jeopardizes their own future competitiveness as well as escapes from obvious growth and welfare opportunities. Across the EU-countries, only around 30% of the SME's have innovated by introducing a new or significantly improved product or process (EU Innovation Scoreboard, 2015). For Denmark, the share is slightly higher than the average with almost 35% and for e.g. some of the Baltic countries the share is much lower, around 15%. The challenge is therefore not only to consider, how firms improve their innovative capabilities, but in fact also how they come from being not innovative to introducing their first products on the market. A core challenge for firms is accordingly not only to become innovative, but also to strengthen the innovative capabilities over time to remain innovative or even increase innovativeness.

We observe four major shortcomings in the previous literature:

1. To understand how innovation contributes to competitiveness, one must necessarily disentangle and investigate distinct dimensions of innovation and thereby respect the multi-dimensional nature of innovation. Surprisingly though, very few studies investigate the multiple innovation types and their mutual effects but rather focus on isolated types of innovation (Schlegelmilch, 2016). For a few exceptions see e.g. Ballot, Fakhfakh, Galia, and Salter (2015), Camisón and Villar-López (2014), and Gunday, Ulosoy, Kilic, and Alpkan (2011). In this sense, the former research ignores that companies over time expectedly organize their innovation profiles and strategies involving all types of innovations rather than strategizing on isolated innovation forms. This paper follows the more recent studies by investigating the mutual relationships among product but also process, and organizational innovation.
2. Many studies investigate the adoption of technological and organizational innovations already available on the market and equate these with innovativeness (e.g. one of the early papers Damanpour & Evan, 1984 and has been followed by many papers, also more recently e.g. Camisón and Villar-López, 2014). We argue that these studies deal with issues of diffusion of technologies and as such represent process

innovation, but the innovations that have the potential to generate long-term competitiveness are the product innovations.

In contrast, this study analyses the capability of firms of genuinely generating innovations, whether incremental or radical, and bringing them to the market. Hence, the fundamental premise of this study is that a distinction must be drawn between technology adoption and innovation capability. The paper understands and analyses innovativeness as a firm's capability to develop new and radically new products rather than as a firm's ability to absorb new technologies. Instead, the firm's adoption of new technologies is viewed as important antecedents to support the generation of new products.

3. Some studies investigate firms' product innovativeness, i.e. new products a firm was able to place on the market. These studies mostly rely on perceptual relative measures from one single respondent. In such studies, one manager of the firm is typically asked to assess the degree of innovativeness of the firm's new products relative to its competitors. For examples of such studies see e.g. Schwarz, Faullant, & Matzler (2009) or Luca and Athuahene-Gima (2007).

In contrast, our respondents were asked concretely whether they have introduced new or radically new products to the market within a specific period. The measure is therefore focused on the firm's actual achievements as compared with their attitudes or intentions.

4. Finally, the adoption of technical process innovations as well as the implementation of new managerial practices at the organizational level has typically been investigated using dichotomous measures like if the firm has introduced new managerial practices in the organization (e.g. seen in studies relying on CIS-data) or more detailed case studies of single practices or processes (a similar critique has been raised by Holahan, Sullivan, and Markham (2014)). For examples of such studies see e.g. Ballot et al. (2015) or Gunday et al. (2011).

In this respect, this study is unique as the paper investigates the adoption of 13 technical process innovations and 15 organizational practices both in terms of adoption, and in terms of the firm's assessment of their own competencies in using them.

This paper contributes to the current innovation management literature by addressing these four gaps in the literature. Specifically, we investigate the extent and adoption of respectively new organizational practices and new production-related process

innovations, and analyze how these contribute to discriminating between non-innovative, innovative and radically innovative firms. This focus on the relationship between incremental and radical innovation has been an underdeveloped area (Crossan & Apaydin, 2010), and we further add to this line of research the non-innovative firms. By understanding the discriminating factors between these three distinct groups of firms it is likely that we become able to carve out managerial implications with the potential to stimulate the increase in innovative capabilities of firms.

Hence, we investigate how the adoption and extent of use of specific organizational practices and production technologies discriminate between firms that are not innovative, innovative, and radically innovative.

Hence, unlike most other studies, we use the actual adoption of various innovative organizational practices and production technologies as well as the extent to which they have been implemented. Thereby, we are able to compare how breadth and depth in the adoption of organizational practices and technologies influence a company's ability to strengthen their innovative capabilities for generating new products. We further identify the specific technologies and practices that may allow the firm to climb from one level of innovativeness to the next. By this step it is possible to derive implications for managers in stimulating the innovative capabilities of the firm.

2. DEFINING THE INNOVATION FORMS

The starting point for defining different innovation forms must naturally be with Schumpeter (1934) and the famous quote on the different forms of innovation:
(1) The introduction of a new good –that is one with which consumers are not yet familiar – or a new quality of a good. (2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially. (3) The opening of a new market that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before. (4) The conquest of a new source of supply or raw materials or half - manufactured goods, again irrespective of whether this source already exists or

whether it has first to be created. (5) The carrying out of the new organization of any industry, like the creation of a monopoly position (for example through *trustification) or the breaking up of a monopoly position."*

This quote clearly distinguishes the forms of innovation as product, process or new production method, market, material replacements, and organizational innovation. These forms have subsequently been discussed in more detail and very prominently by Damanpour (1991). He defined innovation as a new product or service, a new production process technology, a new structure or administrative system, or a new plan or program pertaining to organizational members (Damanpour, 1991: 556). These forms are closely related to the categories by Schumpeter and demonstrate that innovation is a multi-faceted construct.

The most prominent type of innovation is the product. The product stands prominent and is often (rightfully) equated with innovativeness. The prominence of the concept refers to the role of the product as the main contributor to performance whether related to financial or market performance.

The product is commonly characterized based on the degree of novelty in the offering. Incremental innovation is represented as an improvement and/or line extension involving only minor changes from the existing offering of the firm. At the other end of the spectrum and requiring a fundamentally different process than incremental innovation (Holahan et al., 2014), we find radical innovation. It has even been argued that efforts in incremental innovation may crowd out efforts to pursue radical innovation (see Leonard-Barton (1992) on this point relating to innovative competencies). A radical innovation is characterized by a much higher degree of novelty in the offering (compared to the incremental one) and is new. Intuitively, the innovative efforts towards radically new offerings rest on the assumption that consumers appreciate new features and are fascinated by the new opportunities that the product provides to increase the market performance significantly. Nevertheless, these innovations may despite the expected appreciation of the radically new features in fact be rejected by consumers without consciously considering their potential, so that the adoption process ends before it really has begun (Talke & Heidenreich, 2014).

A second innovative form is the technical innovations, which refer to basic work activities or changed production methods and processes. The literature on process innovation typically equates it with adoption of technical innovations that have been developed by others, e.g. adoption of robots in manufacturing can be considered a process innovation. In this way, process innovation is an internal phenomenon i.e. the innovations primarily and typically benefits the firm itself (Crossan & Apaydin, 2010). On the other hand, new products based on significant changes in the features, forms or functions of the products compared to previous products also hold clear technical content, but this technical advancement is integrated directly in the product.

Damanpour (1991) labels organizational innovation as administrative innovation and it is a means of changing an organization and is as such only indirectly related to the basic work activities, but include the management of these. This is also an internal phenomenon. Other scholars have also used the terminology of behavioural innovation (Avlonitis, Kouremenos, & Tzokas, 1994; Mazzanti, Pini, & Tortia, 2006; Wang & Ahmed, 2004 and Holahan et al. (2014)) including work styles and management methods such as job rotation or downsizing of hierarchies and is also seen as the core subject of change management.

A few studies have investigated the interplay between these various innovation types, and how they affect firm performance (Damanpour & Evan, 1984; Damanpour & Gopalakrishnan, 2001; Jin, Hewitt-Dundas, & Thompson, 2004; Schwarz, Faullant, & Matzler, 2009), whereas Ballot et al. (2015) focus solely on the complementarities among the different innovative forms. As mentioned previously, very few studies investigate the relationships among a more comprehensive set of innovative forms. Camisón and Villar-López (2014) investigate the relationships and find the following significant relationships; between organizational innovation and technological innovative capabilities (positive) and technological process innovation and product innovation (positive). These results follow largely the results of Gunday et al. (2011), who similarly investigate the relationships and also find support for the positive relationship between organizational innovation and process innovation, and from process innovation to product innovation, but not from organizational innovation to product innovation. However, neither of these results provides results on the discriminating factors between the different types of product innovation. But they also

highlight challenges in establishing a significant relationship between organizational innovation and product innovation. In the following these relationships are investigated and in particular how respectively technological process innovation and organizational innovation are related to the degree of product innovation.

3. DATA AND RESEARCH DESIGN

The analyses are based on the multi-topic and multi-country European Manufacturing Survey (EMS). EMS is a European joint survey project carried out in 12 European countries, Turkey and Russia. The current paper is based on EMS data from Denmark that were collected in 2009 (April through June) relating to the previous three years, 2006-2008. The population of firms was delimited to manufacturing companies (NACE 15 to 37) with more than 20 employees (N=3068). 1291 email addresses were retrieved via personal phone call to the company, to which we sent a personalized link to a web-based survey. In total, three e-mail reminders were sent to the respondents, approximately 14 days apart. The final response rate (n=335) calculated on the population is 10.9% (335/3068), and on the number of accepts to receive the survey is 25.9% (335/1291), both of which are acceptable given the complexity of the questionnaire. The sample has been tested for representativeness using sector, region and size (size was calculated on both the number of employees and turnover in last year of accounting) and no significant differences were identified indicating that the study is representative of the population of firms in the Danish manufacturing industries.

In 2009, the companies investigated have been on average 37.4 years old: 68% were founded before 1990, 18% were founded between 1990 and 2000, and 14% were established after the year 2000. Concerning the size of companies we report that on average the companies had 105 employees in 2008, 47% had less than 50 employees employed, 43% had 50 – 249 employees, and 10% of the companies had more than 250 employees.

We performed an aggregation of the manufacturing industry (NACE) according to technological intensity based on NACE Rev. 2 at 3-digit level for compiling aggregates related to high-technology, medium high-technology, medium low-technology and low-technology. Based on this 9% of firms operated in high-technology industries, 29.3%

can be classified as medium-high, 31.9% as medium-low, and 29.9% as low-technology companies.

3.1 VARIABLES

The dependent variable was computed on two CIS-type questions. The first asking the respondent whether the firm has introduced a product new to the firm relating to the period from 2006-2008. The second question asked the respondents whether the firm had introduced new products, not only new to the firm, but also new to the market in the same period. By combining these two questions, we computed the variables into 3 categories: 0 = no product innovation, 1 = product innovation, new to the firm (we further label this type incremental innovation), 2 = product innovation, new to the market (we term this type radical innovation). Importantly we note that the three categories are mutually exclusive, i.e. firm indicating that they were doing both incremental and radical innovation were assigned to the group of radical innovators. Out of 335 valid cases, 165 (49.4%) did not innovate, 71 firms (21.3%) innovated on an incremental level, and 98 firms (29.3%) indicated that they introduced radically new products to the market.

The main explanatory variables for process and organizational innovation are breadth (i.e. the number of practices or technologies adopted) and depth (the extent of use of the practices or technologies). Firms informed about the adoption of 15 organizational practices (like organization of work, organization of production, standardization of knowledge management, working hours and payment schemes, human resource management – see table 1) and 13 technological processes (like automation and linkage technologies, machining and production technologies, digital and IT cross-linkage technologies). As the effect of adoption of organizational practices and technological processes is associated with a time lag, we computed breadth and depth of adoption based on the year 2005 or earlier. By that, we are able to ensure that the adoption of practices and technologies has taken place before the actual generation of innovations (as indicated above 2006 – 2008). We therefore can assure a temporal sequence of technology/ organizational practice adoption -> introduction of new products. Furthermore, the measures as they are based on actual implementation, the year of implementation, and the extent of use (low, medium, high) are both more precise and contrary to the perceptual measures used in other studies, these reflect actual behavior

and investments. Table 1 lists the adoption rate and extent of use for each single technology and organizational practice (in % of the total sample).

Table 1: Adoption and extent of use of technologies and organizational practices

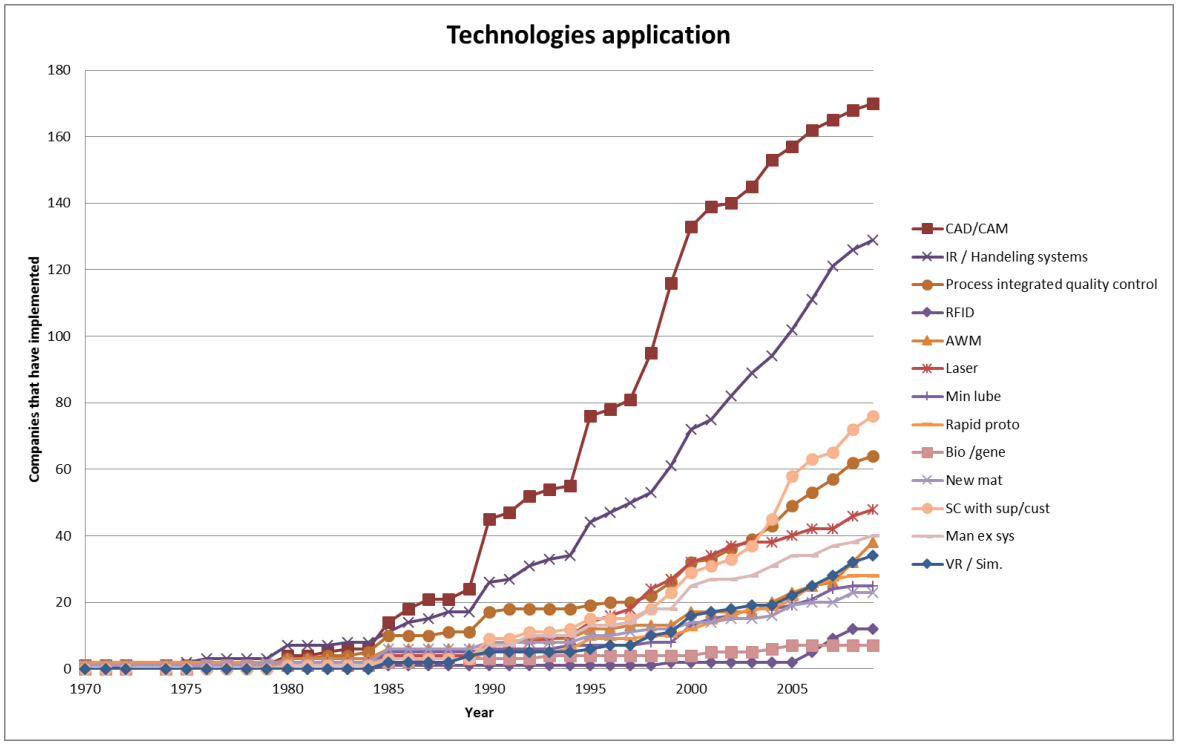
		Percentages			
Type	**Technologies**	**not used**	**low**	**medium**	**high**
Automation and linkage					
	Seamless integration of digital product design	55	7	25	14
	Industrial robots in manufacturing	71	5	13	10
	Integrated quality control (e.g. by laser, ultrasonic waves,)	85	2	6	7
	RFID-utilization in logistics	99	1	0	0
	Automated Warehouse Systems	94	1	2	3
Machining and production technologies					
	Laser as a tool	88	2	2	8
	Dry processing/minimum quantity lubrication system	95	1	2	2
	Rapid Prototyping	94	2	3	2
	Bio- and gene-technology in manufacturing	98	0	1	1
	Processing of novel materials (e.g. composite materials,)	95	1	2	3
Digital factory					
	Digital exchange of operation scheduling data with suppliers	83	3	7	7
	Manufacturing execution system	90	2	5	3
	Virtual Reality, simulation in NPD	93	1	3	3
	Organizational practices				
Organization of work					
	Team work in production	58	2	22	18
	Task integration	59	7	19	15
	Temporary cross-functional project teams	76	3	15	6
Organization of production					
	Customer/product-focused lines	81	1	8	10
	Internal zero-buffer principle	88	2	7	3
	Total cost of ownership	92	1	5	2
Standardization, Knowledge Management					
	Quality Circles	94	1	4	1
	Knowledge base systems	90	3	5	1
	ISO 9000 quality management	68	3	15	14
Working hours, payment schemes					
	Collective arrangement for flexible working hours	75	1	9	15
	Wage systems with team performance incentives	85	1	10	4
	Financial participation for all employment groups	90	3	5	2
Human resource management					
	Regular individual appraisal interviews	45	6	37	12
	Personnel training programmes as a special function of HR	81	1	11	7
	Possibility for employees to work at home	70	8	16	6

The breadth (count variable) for the 15 organizational constructs and the 13 technological processes indicate that on average the companies in the dataset had

adopted 3.4 technologies (min 1, max. 12, standard deviation 1.5) and 4.4 organizational practices (min. 1, max. 14, standard deviation 2.8).

For calculating the firms' depth in organizational practices and technological processes we considered - similarly as in other studies (e.g. Laursen and Salter 2006) – how competent each firm is in using each single organizational practice and technology (0 = no use, 1 = low degree of use, 2 = medium, 3 = high degree of use). On average, firms reached a value in organizational practices depth of 7.7 (min. 0, max. 31; possible max. 45, standard deviation 6.7), the average depth in technological processes amounts to 3.6 (min. 0, max. 23; possible max. 39, standard deviation 3.9). These values appear low, but are a result of the low average breadth of organizational practices and technologies adopted in Danish firms.

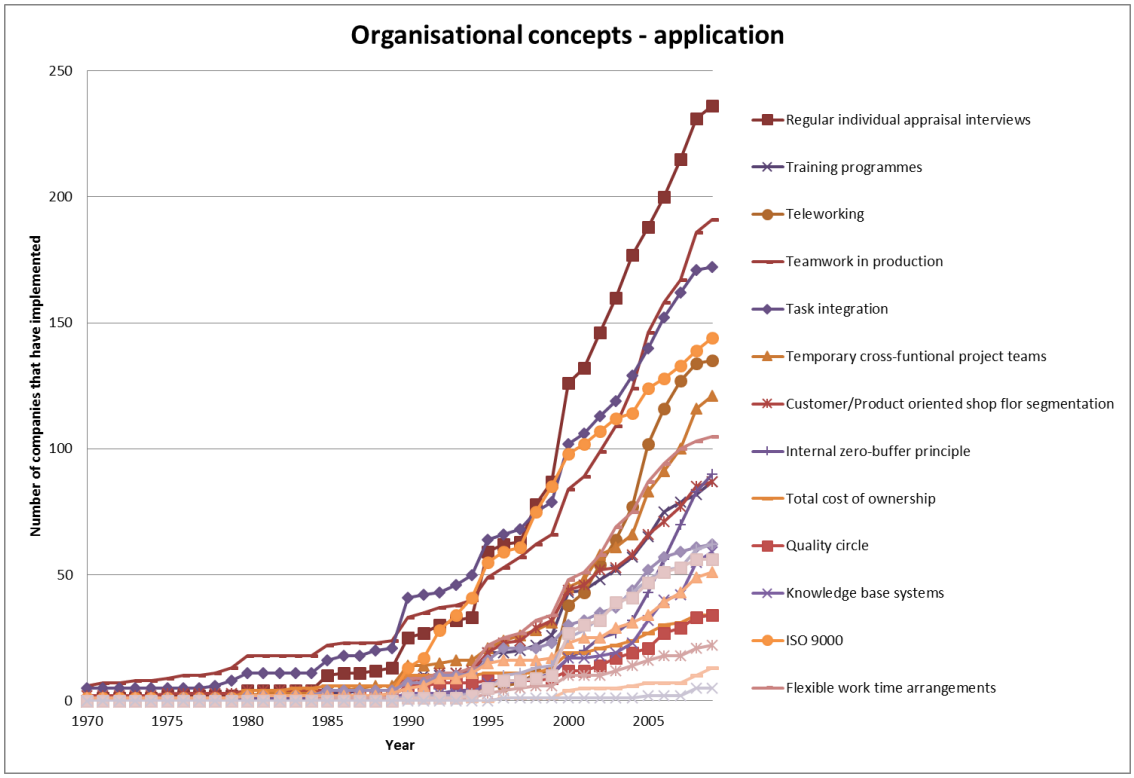
Figure 1: Adoption of technologies over time



To further illustrate the extent of process and organizational innovation, the figures 1 and 2 display the aggregate adoptions of the single technologies and organizational practices. These follow the typical S-shaped course. Among the most widely adopted production technologies, we find CAD/CAM, industrial robots and handling systems, as well as supply chain integration systems with customers and suppliers. Organizational

practices with the largest adoption rate among firms are regular appraisal interviews, training programs and team work in production.

Figure 2: Adoption of organizational practices over time



3.2 DESCRIPTION OF THE THREE INNOVATOR GROUPS

In order to obtain a better understanding of the three groups of our dependent variable, we further describe the characteristics of and the differences between non-innovators, incremental innovators and radical innovators (see table 2).

Table 2: Descriptives of the dependent variables across the three groups

	Non-innovators	Incremental innovators	Radical innovators
Organizational breadth (mean)	3.85	3.77	5.88
Technological breadth (mean)	2.00	2.51	2.81
Organizational depth (mean)	6.39	6.73	10.53
Technological depth (mean)	2.99	3.68	4.30
R&D costs (internal, in % of turnover)	8.76	7.12	12.97
Share of R&D Personal (in %)	2.32	3.80	6.20
Technology levels (in %)			
High-tech	4.20	8.50	17.30
Medium-high tech	23.00	40.80	31.60
Medium-low tech	41.20	17.90	26.50
Low-tech	31.50	33.80	24.50

As expected, radical innovators have adopted on average more organizational practices and more technological processes as compared to the other group. This group also shows the highest level in the extent of use of those practices and technologies adopted, as well as it is distinguished by higher R&D expenditures and a larger share of personal in R&D.

4. ANALYSIS AND RESULTS

Due to the nature of the dependent variable, we use ordinal regression to estimate the impact of organizational and technological breadth and depth on firms' innovation capabilities. We integrated several control variables for our analysis: age (log.), product complexity (simple, medium, high), degree of high skilled employees (dummy for graduate degrees or PhDs in the firm), and the degree of technology intensity at the industry level (dummy for high tech with low and medium as reference). We did not include firm size in terms of employees or turnover since about one third of the respondents did not reply to this question.

We tested for multi-collinearity, but it was not an issue since all VIF coefficients were below 1.5. For estimating the model we used the PLUM (Polytomous Universal Model) procedure in SPSS. The first regression estimates the impact of breadth in organizational practices and technological processes on firms' innovation capabilities. The results of the model indicate a good fit since the Pearson Goodness-of-Fit test ($p= 0.360$) yields a non-significant value.

The results in Table 3 indicate that only breadth in organizational concepts is a significant predictor for a firm's capability to introduce radically new products to the market, whereas breadth in technological processes cannot be seen as a discriminator. Out of the four control variables, the degree of high-skilled employees as well as product complexity has a significant impact on firms' ability to introduce new and radically new products. With both increasing number of high-skilled employees and increasing product complexity, firms are more likely to become more innovative.

The second ordinal regression model (Table 4) estimates the impact of depth, which is a measure of the firms' indicated extent of making use of a respectively adopted practice

or technology. The second ordinal regression model too yields a non-significant Pearson value (p .387) and a non-significant value for the test of parallel lines (p .182).

Table 3: Ordinal regression – organizational & technological breadth

Variables	Estimates	S.E.	Wald	Sig.
Threshold				
No innovation	,721	,559	1,663	,197
Incremental innovation	1,748	,565	9,554	,002
Breadth organizational concepts	,138	,044	10,078	,002
Breadth technical concepts	,057	,075	,580	,446
Age (log)	-,013	,119	,012	,914
Product complexity	,947	,298	10,115	,001
High tech	-,098	,243	,163	,687
Degree of high skilled employees	-,715	,237	9,122	,003
Number of observations	326			
Cox and Snell R-square	0.130			
Nagelkerke R-square	0.148			
Pearson sig.	.360			
Test of parallel lines	.193 n.s.			
Breadth organizational concepts²	.025	.012	4.168	.041

Reference category: radical innovation
Level of significance: *p < 0.05. **p < 0.01 and ***p < 0.001

Again, only the depth in organizational concepts is a significant predictor for firms' innovation capability while the extent of use of technological processes is not significant. As in the first model, product complexity and the degree to which firms' have highly skilled employees allows us to discriminate between their ability to introduce new or radically new products. In both regression models we tested for several interaction effects between the two main explanatory variables and the control variables, but none were significant. Finally, we also controlled for the squared terms of the significant main effects, i.e. the question whether breadth and depth in organizational practices shows a linear relationship with the innovative capabilities. Or whether there exists a curvilinear relationship, which would indicate that at a certain point having adopted more practices and to a larger extent will no longer yield positive returns for innovation. The analysis yields a positive and significant value for both squared terms, organizational breadth and depth. This means that there is no negative tipping point for the adoption of organizational practices.

5. NON-INNOVATORS, INCREMENTAL INNOVATORS, AND RADICAL INNOVATORS

In order to detect significant differences among non-innovators, innovators and radical innovators related to the single practices and technologies, we further analysed the individual organizational practices and technologies. Multivariate analysis of variances (MANOVA) was performed to compare the means of the three sub-groups along the implemented organizational practices and technology levels. Pillai's Trace test is highly significant (.008) and yields a partial squared eta of .153.

Table 4: Ordinal regression – organizational and technological depth

Variables	Estimates	S.E.	Wald	Sig.
Threshold				
No innovation	.669	.555	1.454	.228
Incremental innovation	1.689	.561	9.071	.003
Depth organizational concepts	.061	.019	9.903	.002
Depth technical concepts	.009	.033	.074	.785
Age (log)	-.005	.119	.002	.968
Product complexity	.978	.296	10.878	.001
High tech	-.082	.242	.114	.736
Degree of high skilled employees	-.737	.236	9.751	.002
Number of observations	326			
Cox and Snell R-square	0.123			
Nagelkerke R-square	0.140			
Pearson sig.	.387			
Test of parallel lines	.182 n.s.			
Depth organizational concepts²	.005	.002	4.406	.036

Reference category: radical innovation
Level of significance: *p < 0.05,**p < 0.01 and ***p < 0.001

Therefore, the null hypothesis can be rejected according to which the means over the three sub-groups are equal. The detailed comparison of groups reveals that there are significant mean differences within 2 technologies and 9 organizational practices. We list the significant differences for the group comparisons between non-innovators and incremental innovators and between incremental and radical innovators in tables 5 and 6 (Levene's test was used to test for equality of variances, T-test for equality of means).

5.1 NON-INNOVATORS VS. INCREMENTAL INNOVATORS

Incremental innovators differ from non-innovators mainly with respect to the adoption of process technologies and production-related organizational concepts, i.e. rapid prototyping, manufacturing execution systems, total cost of ownership assessment and

temporary cross-functional project teams. Surprisingly rapid-prototyping discriminates only between non-innovators and incremental innovators, but not between incremental and radical innovators. We interpret this finding in the context of time when the data was gathered. In 2009, the range of possibilities of rapid prototyping technologies was still very limited and we therefore would see this technology rather as a state-of the art indicator for innovative companies in general, than having the potential to really make a performance difference.

Table 5: Non-innovators vs. incremental innovators

Technology/Organizational Practice	T	df	Sig. (2-tailed)
Rapid Prototyping	-1.959	81	,054
Manufacturing execution system (MES)	-2,169	98	,033
Temporary cross-functional teams	-2,023	113	,045
Total cost ownership	-2,082	80	,040

5.2 INCREMENTAL VS. RADICAL INNOVATORS

Taking innovation capabilities to the next level mainly requires efforts relating to the organizational practices; i.e. organizational innovation. We find the differences between incremental and radical innovators exclusively lying in the implementation of organizational practices, i.e. task integration, customer or product-focussed lines in the factory, knowledge base systems, regular individual appraisal interviews, possibility of employees to work from home, wage systems with team performance incentives, and financial participation by employees eligible for all employees.

Table 6: Incremental vs. radical innovators

Technology/Organizational practice	T	df	Sig. (2-tailed)
Task integration (planning, controlling, monitor by machines)	-2,207	164	,029
Customer or product-focussed lines in factory	-1,936	166	,055
Knowledge base systems of employee qualifications	-2,282	166	,024
Regular individual appraisal interviews	-2.019	167	,045
Possibility for employees to work at home	-2.462	164	,015
Wage systems with team performance incentives	-2,636	165	,009
Financial participation by employees eligible for all employees	-2,118	151	,036

The analytical results thus show that the adoption and the competence in using technological process innovations are not related to the innovative capabilities of the firm as measured by their ability to bring radically new products to the market, whereas the adoption and use of organizational practices are important and positively discriminate between non-innovators and incremental innovators against radical innovators. Hence, more organizational practices and better use of the organizational practices positively facilitates that the firms' generate radically new products to the market. Making the leap from incremental to radical innovations thus requires additional investments by the companies in the implementation of organizational practices.

On a more abstract level, we find that radical innovators are good in managing two seemingly contradictory poles of organizational practices. On the one hand, they highly integrate tasks by optimizing the use of resource through sophisticated planning systems such as task integration, customer or product-focussed lines in the factory, and knowledge base systems documenting not fully exploited qualifications. On the other hand, they also show a high level in realizing practices that allow for individual flexibility and self-determination, like flexible working hours and holding individual appraisal interviews. The fact that they also favour wage systems with team performance incentives and profit sharing for all employee groups might constitute an additional glue that ties the organization together and motivates all employee groups the like to contribute to new product innovation.

6. DISCUSSION AND IMPLICATIONS

The descriptive analysis indicates that almost 50% of the firms in this sample are not-innovative, i.e. they have not introduced a new product on the market in a three year period. Further, less than 30% have introduced new products that are new to the market and possess sufficient newness to directly address the competitors' products. Clearly, the challenge for managers is to consistently focus on stimulating the innovative capabilities of his firm and especially to focus his attention towards relevant and appropriate mechanisms to increase the innovativeness. While previous research often equals adoption of innovations with a firm's innovativeness, we called for a more differentiated view. Many firms adopt various technologies and organizational

practices, but not all of them seem to be equally successful in facilitating the generation of new products to be launched on the market; even rarer are those companies that are able to introduce radically new products to the market.

Our study investigates in detail, the relationship between adoption of production technologies; i.e. process innovation, and implementation of organizational practices; i.e. organizational innovation, and the relationship with the firms' capability to generate new products. We aimed to identify the differences in the breadth and the depth of adoption of various technologies and organizational concepts by investigating the research question:
How does the adoption and extent of use of various organizational practices and production technologies discriminate between firms that are not innovative, innovative, and radically innovative?

The regression results revealed that on an aggregate level only breadth (i.e. the number) and depth (i.e. the extent of use) of organizational practises are significant determinants of firms' capabilities of generating new products/offerings for the market. Importantly the analysis of the squared terms furthers the conclusion that firms cannot adopt and apply too many organizational practices; there is a constant and in marginality even increasing positive relationship with the firm's innovative capability. Furthermore, and perhaps also somewhat surprising, the technological process innovations do not find support in this research.

These results challenge the findings of e.g. Gunday et al. (2011) and Camisón and Villar-López (2014), who found that technological process innovation was positively related to product innovation, whereas both these studies were not able to find a significant relationship between organizational innovation and product innovation. One reason for this may be the extension of these studies carried out in our study as we also investigated how non-innovators and innovators differ. The results reveal an interesting pattern: in order to innovate, at all, firms have to meet a certain technological threshold. In particular, the analyses showed that incremental innovators differ from non-innovators mainly in the extent of the adoption of certain technologies and core-production related organizational concepts aiming at process improvements such as total cost of ownership assessment. Therefore, instead of a general broad technological

adoption behaviour, rather some specific technologies support the generation of new products and in particular these mirror the results of the previous studies.

Furthermore, the role of organizational innovation for stimulating radical innovation is evident from this study. In particular, taking innovation to the next level, i.e. the ability to place radically new products on the market, is exclusively related to firms' willingness and ability to adopt more organizational practises and to implement them deeply in the organization. This finding has important implications for firm managers, as it suggests that a focus on mere technology adoption will not be sufficient for becoming more innovative. Instead, managers should consider implementing more of the organizational practices we have listed and carefully think about how they can be filled with live within the organization, i.e. implementing and making use of them to a high degree.

With this analysis, we are to our best knowledge the first to conceptually disentangle adoption and diffusion of technologies from firm innovativeness, i.e. the ability of firms to genuinely introduce new offering to market. This is an important distinction as the mere adoption of new technologies and practices available on the market does not directly translate into the development of new products. Indeed our results suggest that actually adoption of technologies does not make a large difference whereas adoption and use of organizational practices is directly related to the introduction of new products/offering on the market. Our study further contributes to the extant literature in that our analysis is based on actual adoption behaviour (plus extent of use) and the actual innovative achievements, as measured by new products introduced.

Overall, our findings suggest that mere adoption of technologies is not enough for being able to generate radically new products, but are important for building innovative capabilities in non-innovative firms. Instead, firms have to invest in the implementation of organizational practices fostering both high task integration for smooth operating and flexibility in work time as well as favouring collective payment incentives over individual incentives.

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