From idea to innovation

The determinants of innovation within Dutch SMEs and their interrelatedness

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1. Introduction

"Prosperity: the condition of being successful or thriving; especially: economic well-being"
The reason to depart with a definition of prosperity[1] is that throughout history economic growth and well-being has become the focus of most nations as it affects every single one of us. Not only when considering leisure and luxury yet also when thinking about health and other basic human needs. Yet, what is of greatest importance and what we should remember here is that innovation and economic growth is mainly determined by the share of R&D and more specifically by the productivity of employees working in R&D (Romer, 1990). From the preceding it is taken as self evident that the most important component of economic growth and well-being is innovative activity. The aim of this thesis is to look at the origins of innovative activity and its determinants i.e. on individual and firm level in the current era.

Directing towards the objectives of this work the question is where does this innovative activity takes place and more important what are its determinants. Answering the first part of the question, the locus of innovative activity in this thesis will be Small and Medium sized Enterprises (SMEs) which is sustained by the shift from the "managed" to the "entrepreneurial economy" as elucidated by Audretsch and Thurik (2004). *"While small business was a follower in the managed economy, it has emerged as the engine of growth in the entrepreneurial economy"*(Audretsch and Thurik, 2004, p. 13).

The choice to conduct research on innovative activity within SMEs is further backed up by the fact that they do innovate with great efficiency and score high on the commercialization process (Van Praag and Versloot, 2007) and with this SMEs are boosting employment, economic growth and dynamics (Baumol, 1990). Numerous studies have done research on the innovative activities within firms in general both on its determinants and importance. In today's ever changing world and economies where one product, technology or innovation follows the other at an increasingly growing pace the ability to adapt is crucial for a firms' survival. Innovation is considered to be a key driver for the long term prosperity of a firm as organizations in today's competitive markets with the competencies to innovate will be capable to react better and faster to their changing environment (Wolfe, 1994; Baumol, 2002).

[1] Definition of prosperity as taken from the Merriam-Webster dictionary.

One of the most important means by which SMEs are able to do so is through their capability to realize and implement innovations. Knowing this, many efforts are made both in developed and developing countries to stimulate SMEs in this process. For example, SMEs have been encouraged to make use of funding schemes, if available, and to utilize linkages with knowledge centres. However, despite of many research and effort there exists still a lack of knowledge about the extent of SME support needs and effective mechanisms delivering it resulting in a wide range of policy experimentation (Bessant, 1999).

Attaining a better understanding about what propels SMEs to innovate and by which means they undertake such innovative activity could answer questions yet unresolved. The first step is to investigate which factors affect the innovation efforts and in which way (Keizer et al., 2002). Some researchers argue that SMEs are integrated within their area of existence to a much larger extent than large firms and in such their determinants of innovation depend on specifications of that area (Kaufmann and Todtling, 2002). For instance, Keizer et al. (2002) demonstrate that having linkages with knowledge centres, making use of innovation subsidies and the relative amount of turnover invested back in R&D are the factors of most importance for innovation in Dutch SMEs.

When reviewing literature on factors determining innovation within SMEs often a distinction is made between internal and external variables. Internal variables are the characteristics and policies of the SME whereas external variables are the characteristics and opportunities an SME can seize from its environment (Keizer et al., 2002). Internal factors reoccurring in literature and shown to be important to innovate are a high incidence of qualified scientists and engineers (QSEs) and a higher educated founder or director providing strong leadership (Hoffman et al., 1998). However, some research does not find these effects (Keizer et al., 2002). Other important internal factors linked to innovation are shown to be the existence of technology policy instruments within the organization and planning for the long term (Oerlemans et al., 1998). Another internal factor is strategy. Specifically strategies to provoke and increase creativity and risk taking behaviour are mentioned to have impact on innovation (Birchall et al., 1996). A non excludable variable in literature considered to have a positive effect on innovation efforts is the investment in R&D (Birchall et al., 1996; Oerlemans et al., 1998).

Considering the external factors which show to have a positive contribution to innovative activity, Keizer et al. (2002) group them into three categories: linkages or collaboration with knowledge centres, collaboration with other firms and the utilization of financial support regulations. E.g. entrepreneurs find collaborations with other organizations very important regarding their innovative efforts (Massa and Testa, 2008) and other studies show that collaboration with suppliers can contribute to the SMEs innovativeness as well (Kaminski et al., 2008). The purpose to collaborate with suppliers and consumers together may be aimed at co-designing (Birchall et al., 1996) and the collaboration with consumers alone can provide a source of improving technology. Linkages with knowledge institutions consist of input from consultants, technology centres and university research (Hoffman et al., 1998; Oerlemans et al., 1998). Considering the utilization of financial resources, R&D funding has shown to be an important variable influencing innovative efforts within SMEs (Birchall et al., 1996; Hoffman et al., 1998).

Given the importance to innovate researchers have tried to identify the determinants of this innovative capacity and not surprisingly the classical view is that R&D is the driving force behind innovation (Miller and Morris, 1999; Mairesse and Mohnen, 2005). In order to innovate and profit from this by successful commercialization firms must synthesize knowledge and expertise from different complementary sources which can be accomplished by means of R&D. In fact, R&D can generate new knowledge and simultaneously improve the firm's innovative capacity by enhancing the ability to recognize and exploit existing knowledge (Cohen and Levinthal, 1990). However, when regarding SMEs as the unit of analysis literature on R&D needs to be reconsidered. Within SMEs there is a higher probability that informal R&D is carried out and formal R&D is in some cases only slightly related to innovation (Hall, 1991; Acs and Audretsch, 2005). R&D data is used for a long time as a proxy of innovative activity simply because its availability in statistics. However, due to the confined extent of (formal) R&D activities within SMEs alternative determinants should be assumed to play a key role in the context of innovative activity.

When R&D shows to be less apparent or less intensive e.g. in the case of SMEs or low-tech industries, research becomes poor and inconclusive. The main research question of this study therefore is:

"What are the determinants of product innovations within Dutch SMEs and how do they interrelate?"

As most of the research on innovation within SMEs focuses on technology abundant industries, we know little about the characteristics of innovative SMEs in general nor about their fundamental determinants (Hoffman, 1998). Since SMEs mostly do not tend to innovate in formally acknowledged ways, R&D expenditures, patent applications and other statistics are likely to be a tip of the iceberg. In this study we attempt to capture the determinants of innovative Dutch SMEs by comparing them to the less or non-innovative SMEs. In addition, various not purely technological industry sectors are included ranging from e.g. food related firms to consultancy firms. The former raises another obstacle as how to define an innovative SME. We gathered data from 120 various SMEs throughout The Netherlands from which 60 participated in the Dutch Syntens Innovation Top 100 award[2] in previous years. We will elaborate on the method and measurement later on.

Much research has been done on the factors contributing to innovation both to develop a more thorough theoretical framework and to substantiate practical interventions. These studies show that activities conducted to innovate correlate with a substantial number of variables. Most research focuses on either internal or external variables yet Keizer et al. (2002) included variables from both groups in their research. An important attribute under these studies is that little or no focus has been laid on the possible interactions between variables (Keizer et al., 2002). Therefore, under this study the separate variables which are ought to be linked to innovation will be grouped into three main factors according to literature and their interrelatedness will be tested.

[2] The innovative organizations participating in this award are judged on their impact and contribution to society, originality, commercialization of the innovation and degree of protection. For more information visit: http://www.syntens.nl/innovatietop100/Pages/MKB-Innovatie-Top-100-home.aspx

In the main body a theoretical framework will be build around the process of innovation from idea to commercialization out of which the hypotheses will be drawn up. This will be done from a perspective of three main flanks as just mentioned which are ought to be important namely: Knowledge creation, absorption and appropriation, Organizational creativity, and Entrepreneurial capital. What is interesting under this study is that not only the mentioned expected determinants are tested for their influence on innovative activity yet also their interrelatedness. Thus, the interactions of Knowledge creation and appropriation, Organizational creativity and Entrepreneurial capital are hypothesized and tested. To my best knowledge a study like this on the above mentioned determinants of innovative activity within SMEs has not(hardly) been done before.

The relevance of this study speaks for itself as most economies are predominantly composed of SMEs which account for the lion part of employment and economic growth. Even though large firms are present and necessary it is the group of SMEs which is currently in the spotlight of research and conduct. The innovative characteristics and behaviour of SMEs leading to economic growth and job creation are recognized to be valuable and worthwhile exploring. Moreover, giving insight into the more specific determinants of innovation within SMEs could improve managerial practices on firm level and government policies on national level to foster innovation and growth. First some definitions and measurements of innovation will be discussed and categorized.

2. Theoretical framework

2.1 Defining and measuring Innovation

2.1.1 Defining Innovation

When talking about innovative activity within SMEs it is important to give a definition of innovation which is easier said than done as the term is notoriously ambiguous and has no overall nor clear definition (Cooper, 1998; Adams et al., 2006). Considering the literature on the concept of innovation several "more general" definitions are represented in table 1. It can be noticed that since the introduction of the concept of innovation by Schumpeter the definitions have stayed quite consistent. Almost every definition starts with a "new idea" which is close to an invention still the terms transformation and implementation/commercialisation are mentioned in the same phrase denoting that an invention does not equal an innovation yet only in its narrowest sense (Drucker, 1994; Gurteen, 1998; Baregheh et al., 2009). In addition, it is notable that the concept of innovation is transforming from a phenomenon external to the firm to a purposive act of the firm, that is: making innovation happen (Gurteen, 1998; Love and Roper, 1999; Baregheh et al., 2009). Baregheh et al. (2009) attempted to come to a multidisciplinary definition of innovation by generating a representative pool of definitions from different disciplines in literature and proposed both a diagrammatic and a textual definition of innovation as can be seen in table 1. This definition together with the definition of the Oslo Manual (2005) is probably the closest we get when trying to capture innovation within a single expression. Yet there is more to the term innovation as there are different types of innovation to distinguish making the concept of innovation even more complex.

Table 1. Definitions of Innovation

1939, 1947	Schumpeter	*"..carrying out of new combinations."*
1973	Zaltman et al. p. 10	*"..any idea, practice or material artefact perceived to be new by the relevant unit of adoption."*
1998	Gurteen p. 6	*"..the sifting, refining and most critically the implementation of ideas. It's about putting generated ideas into action."*
1999	Love and Roper p. 48	*"..a commercial rather than a technological activity, which is related to and affects firms' competitive position."*
2005	Oslo Manual 3rd edition, p. 46	*"..the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations."*
2009	Baregheh et al. p. 1334	*"..the multi-stage process whereby organizations transform ideas into new/improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace."*

2.1.2 Types of innovation

Most types of innovation can be viewed as dualisms e.g. product vs. process, radical vs. incremental, competence enhancing vs. competence destroying and technological vs. administrative innovation (Cooper, 1998; Schilling, 2005). Product innovation indicates an alteration in the end product or service which can be a significant improvement in technical specifications or components and material. On the other hand, process innovation indicates changes in the means and process by which these products and services are generated e.g. changes in techniques, equipment and/or software (Cooper, 1998; Oslo Manual, 2005). Another dualism is technological vs. administrative innovation where the first is the adoption of a new invention which directly influences the final output, whereas the latter indicates e.g. changes in the allocation of resources and other factors linked to the social structure of the firm (Damanpour, 1989; Cooper, 1998). An important distinction to make is that the two latter dualisms say something about the nature of the innovation while radical vs. incremental and competence enhancing vs. competence destroying innovations give information on the impact of the innovation (Damanpour, 1989; Henderson and Clark, 1990; Schilling, 2005). For example, incremental innovations can be seen as minor adjustments to enhance or extend a product or process whereas a radical innovation is a path-breaking and discontinuous innovation (Oslo Manual, 2005; Schilling, 2005). The first can be viewed as evolutionary and the second as revolutionary, hence this categorization tells something about the impact of the innovation. Another classification considering the impact of innovation is competence enhancing vs. competence destroying innovation. Competence destroying innovations call for new resources and knowledge devaluating the existing ones within the firm.

At the other hand, competence enhancing innovations make use of the existing resources within the firm strengthening them and preferable improving their competitive position (Tushman and Anderson, 1986).

Even though there are a lot of different perspectives on innovations there is also some overlap to be found. Both radical/incremental and competence enhancing/competence destroying innovations consist of two extremes with a classifying continuum in between. In addition, a radical innovation makes e.g. a product obsolete and in this way is closely related to the competence enhancing/destroying classification. A difference is that as the typology incremental/radical innovation says something about the external impact, the competence enhancing/destroying typology takes an internal perspective.

Regarding the nature of an innovation the Oslo Manual (2005) gives, next to product and process innovation, additionally marketing and organizational innovation. Marketing innovation is the realization of a new way of marketing which can be a significant change in product design/packaging or product promotion/pricing. Organizational innovation is the implementation of a new organizational method in the firm's business practices, workplace organization or external relations. Obviously there is other literature and typology on the nature of innovation as well. Krebbekx et al. (2006) gives a comprehensive typology framework concerning the nature of innovation which is more practice based and rather eclectic. The five types described, here in a concise way, are *physical product innovation* which is an innovation regarding a physical end-product, *service innovation* which is an innovation concerning a non-physical end-product, *production process innovation* which is an innovation regarding the primary production process, *secondary process innovation* which is an innovation regarding the secondary processes and organizational structure within the firm, and *social innovation* which is an innovation concerning the social network, corporate culture and human resource management. The first three definitions are quite similar to the definitions mentioned in economic papers yet the last two are somewhat vague and will be briefly explained. Secondary process innovations are innovations regarding the organizational structure and secondary procedures like R&D processes and the sales/marketing department. The focus is on the organization as a whole. On the other hand, social innovations are focused on the individuals representing the organization and regularly involve a change in attitude, thinking and actions (Krebbekx et al., 2006).

Again these different perspectives and typologies on the nature of innovation show similarities and overlap. Take for example the definitions of product and process innovation given earlier. These can now be extended by the first four definitions given by Krebbekx et al. (2006). On the contrary, marketing and organizational innovation described earlier can be now classified under social innovation and this whole category is similar to administrative innovation given formerly. Figure 1 classifies and depicts the different types and impacts of innovation for a better overview. Note that this model does not try to capture the whole concept of innovation yet only contributes to a better comprehension. The purpose to briefly discuss these definitions from management practices by Krebbekx et al. (2006) next to the (applied) economics definitions is to extend the view on and accentuate the complexity of different types of innovation.

Moreover, next to these similarities and overlap in the types and terms concerning the nature and impact of innovations there exists a high interdependency (Damanpour, 1989; Krebbekx et al., 2006). For example, what is seen as a product innovation for one firm can be used as a process innovation by a second firm. In addition, one type of innovation can institute another type and vice versa impediments resulting from one innovation can have its effect on other types of innovation.

2.1.3 Measuring innovation

In the scope of this research innovation by a firm is confined to physical product(service) innovations. One reason for this choice of measurement is that product(service) innovations are tangible and less ambiguous than e.g. social innovations which contributes the validity. As the Oslo Manual (2005) states, the broad use of the definition innovation and addition of different types implies that an increasing percentage of firms meet the basic requirements to be innovative. It is not sufficient to know whether a firm is innovative or not yet distinguishing between the types of innovation can contribute to a better understanding of the innovative capabilities and activities.

The measurement method identifying an innovative firm in this thesis will be clarified in detail under the empirical part. However, it should be clear that the ground to measure actually commercialized product(service) innovations is due to the severe drawbacks in most other commonly used measurements of innovation (Kleinknecht et al., 2002; Acs and Audretsch, 2005; Hall, Jaffe and Trajtenberg, 2005).

One of these commonly used measurements of innovation are Research and Development expenditures yet this is an input to the process of innovation and an input is as good as its efficient use by the processors towards the output. In addition, SMEs often tend to innovate without formal R&D expenditures resulting in R&D being an input in some yet not all cases (Kleinknecht et al., 2002; Acs and Audretsch, 2005). Other commonly measurements are patent and patent citations with the drawbacks being patents which are not commercialized, also known as sleeping patents, and the fact that especially SMEs do not tend to patent innovations at all (Kleinknecht et al., 2002; Hall, Jaffe and Trajtenberg, 2005). For a detailed analysis of the measurement methods the cited papers are referred to. Giving an in depth description of the different innovation measurement methods would be outside the scope of this research as we investigate the determinants of innovative SMEs. Thus, a classification of innovative SMEs by direct measures of their innovative output suffices and is besides preferred in many cases (Kleinknecht et al., 2002; Acs and Audretsch, 2005). Having demarcated an innovative SME the following parts will deal with the expected components making up this innovative SME.

2.2 Knowledge Creation and Absorption

Directing towards the determinants of innovative activity within SMEs the definitions of innovation together with one of the inputs just mentioned, R&D, have to be elaborated. The process of innovation is often described as an idea or invention which has to be commercialized (Gurteen, 1998; Adams et al., 2006; Krebbekx et al., 2006). First, we will elaborate on the creation and appropriation of this ideas/inventions within the firm, hence the creation and appropriation of knowledge. Next, we will discuss how the traditional view on the knowledge base within the firm, formal R&D, differs in the case of SMEs and discuss its relation to the absorptive capacity of the firm.

2.2.1 Knowledge base

The importance of knowledge has been increasing over time and advanced economies are expected to move towards the so called knowledge-based economies where knowledge becomes the main competitive asset of firms.

This shift has taken over a hundred years by which R&D is institutionalized (Freeman and Soete, 1997), and is accompanied by a large expansion of higher education on all levels. Consequently, the intangible capital in economic life has slowly become more important than the tangible capital (Foray, 2000). Intangible capital, as the term already indicates, is not simply embodied in the R&D division of an organization but is defined by interactions of the diverse elements of knowledge contained by the individuals within that organization or firm. The knowledge base of an organization is defined here as the embedded collective knowledge of individuals within the firm (Nonaka et al. 2000) used to achieve the firm's productive purposes and final output (Saviotti et al., 1998). The knowledge base has a collective character as it is a necessity for interaction to take place among the individuals of the firm. The final output of an organization can be only accomplished when the large amount of individual stages of production are coordinated and combined. The specific fashion of division of labour in each firm determines the types and the frequency of interactions taking place within the organization. Since any sequence of interactions alters the knowledge base yet the interactions themselves are defined by the knowledge base, the knowledge base of an organization might evolve over time. However, since a firm mostly holds a set of decision rules and routines that are not modified frequently, the knowledge base attains a certain stability (Saviotti et al., 1998). This implicates that the knowledge base of a firm can be expected to be quite specific and have a substantial degree of path dependence. Despite the general recognized importance of knowledge in economic activity little is known about the manners in which organizations create and use knowledge.

To state that firms make use of knowledge seems quite obvious since any productive activity always requires some kind of knowledge. Nevertheless, what is interesting to modern organizations is their use of knowledge coming from institutions with the creation of knowledge as their main goal. This is a modern phenomenon which follows from the institutionalization of science in universities and the following institutionalization of industrial R&D (Freeman and Soete, 1997). Accordingly, firms nowadays make increasingly use of both scientific and technological knowledge created by organizations outside the boundaries and sector of the firm itself. In addition, current firms may have departments or divisions specifically appointed to create knowledge, something contrary with previous periods when the creation of new knowledge took place simultaneously with its utilization.

Despite these shifts in the creation and appropriation of knowledge firms are still not primarily knowledge creating organizations yet they use knowledge to compete. The competition takes place amidst the final output of these firms. Hence, one can say that an organizations knowledge base is used to produce its revealed technological performance (RTP). In the sense that knowledge is a requisite to develop new products the creation of a new knowledge base will have to precede that of new products however the knowledge base and RTP follow related but separate dynamics (Saviotti et al., 1998). This means that in a way the revealed technological performance at a time t will encompass the knowledge base at a previous time t-Dt. The dimension of the delay Dt probably depends on characteristics of the firm, the firms sector and technologies concerned (Saviotti et al., 1998). Nevertheless, some studies show that the dynamics of the firms knowledge base and products are not always identical. For example, it is possible for products to become more and more differentiated while the knowledge base of the firm remains the same and vice versa. In addition, organizations make use of more technologies besides the ones which they include in their products (Brusoni et al., 2000). Summarizing, the knowledge base of the firm can be seen as the collective knowledge within the firm used to achieve its productive purposes. The production of knowledge does not have to follow the same path as the production of goods and services yet both are as likely to be produced through the division of labour.

Obviously for a firm to be inventive it has to pass a certain threshold of holding knowledge which is called the knowledge base. The accumulation of the knowledge base can take place internally and externally with the most common internal component being R&D. R&D has been recognized to be an input factor and acknowledged to be closely related to innovation for more than five decades (Miller and Morris, 1999). However, despite the fact that formal R&D within SMEs could contribute to its innovative output, the extent of informal R&D is considerably higher (Acs and Audretsch, 2005). In addition, in some cases there is evidence of non-sequitur as R&D intensity is only slightly associated with the performance of SMEs (Hall, 1991).

Manners for SMEs to practice informal R&D are e.g. under its marketing and sales divisions or even outsourcing R&D without having a separate in-house (informal) R&D department (Oslo Manual, 2005; Malerba, 2005). SMEs can as well buy or receive R&D, ideas, patents and inventions from third parties.

Additionally, as the knowledge base is fundamentally represented by the individuals within the organization, attracting higher educated personnel as well as qualified scientists and engineers (QSEs) could be a form of informal R&D. Moreover, research shows that having a high incidence of QSEs within the organizations and a higher educated management department or founder(entrepreneur) can contribute to innovative success in two ways: first through their direct R&D effort by means of the knowledge and ideas they possess and second as the managers of the SMEs' relations with external sources (Moore and Sedaghat, 1992; Hoffman et al., 1998).

As mentioned before, next to the internal sources of knowledge, there are external sources of knowledge contributing to the knowledge base and both are often regarded as complementary (Saviotti, 1998; Caloghirou et al., 2004). The external sources can be defined as external network linkages serving the knowledge accumulation process. Research on innovation stresses the importance of interaction between various organizations to foster the innovation process (Rothwell and Dodgson, 1994; Von Hippel, 1994). The innovative activity of a firm can be enhanced by, and in some cases (SMEs) depends on, corporation with other entities such as suppliers and users (Von Hippel, 1994), universities and research centres (Cohen et al., 2002) and even competitors. Thus, external knowledge linkages with other firms or governmental institutions such as innovation platforms can very well serve as informal R&D practices contributing to the innovation process of SMEs (Freeman, 1994; Rothwell and Dodgson, 2007). In addition, different research indicates that a positive contribution can be found of R&D within universities towards the private sectors' innovative output depending on the quantity and quality (Feldman, 1994; Fritsch and Slavtchev, 2007), meaning that external linkages with universities can contribute the knowledge base. This reasoning concerning internal, external, formal and informal R&D concerning the knowledge accumulation process implies that SMEs holding a larger knowledge base are more likely to be involved in innovative activities.

2.2.2 Absorptive capacity

Having a substantial knowledge base is necessary to absorb external knowledge as individuals within the firm have to be able to recognize and assimilate this new knowledge, a phenomenon defined as absorptive capacity (Cohen and Levinthal, 1990). The absorptive capacity is part of the knowledge base and the two terms are therefore often used interchangeably.

Hence, we are dealing with a mutual process as the knowledge base consists out of internal and external sources and to absorb the external sources a certain level of internal knowledge is essential (Saviotti et al., 1998). Vice versa, the absorptive capacity of a firm has a positive influence on the internal knowledge accumulation process through the knowledge base (Veugelers and Cassiman, 2002; Malerba, 2005).

The concept of absorptive capacity was first introduced by Cohen and Levinthal (1990) and defines a firms' ability to recognize, assess and apply new knowledge. Further studies on the theory and models of absorptive capacity have led to the term dynamic capability which is defined as *"the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments"* (Teece, Pisano and Shuen, 1997, p.509-533). In this sense the absorptive capacity to recognize valuable knowledge is vital for a firms' innovative capabilities and performance (Cohen and Levinthal, 1990; Volberda, 2007). Moreover, the innovative capability of a firm is improved as a larger absorptive capacity leads to a larger range of resources, and given the fact that innovations are often a new combination of present resources the innovative capacity is enhanced (Volberda, 2007). As stated before the ability to absorb external knowledge builds upon and depends on the knowledge base and explains why firms should develop a minimum threshold of organic knowledge themselves (Cohen and Levinthal, 1990). According to Cohen and Levinthal (1990) absorptive capacity can be created by the extent of R&D yet they also mention the training of personnel and generation of the required background knowledge as a by-product of the working process. When regarding absorptive capacity in SMEs the focus should be more on human capital and human resources as alternative components i.e. learning by doing and using (Feldman, 1994) which very often comes in tacit forms (Von Hippel, 1994). The absorptive capacity within SMEs can be represented not only by formal R&D yet also by the amount of qualified scientists and engineers and the formal education level of the employees (Hoffman et al. 1998; Vinding, 2004), hence in terms of human resources. Moreover, these (qualified) human resources play an important role in the assessment of external linkages and the appropriation of the acquired knowledge (Narula, 2004). In order to be innovative firms have to accumulate and handle as well internal as external knowledge coming from various sources in non linear flows.

2.2.3 Hypotheses

By this reasoning about the necessity of a minimum knowledge base accompanied by the absorptive capacity to enhance the innovative capabilities, the following hypothesis is drawn up:

> *Hyp. 1. A higher level of the knowledge base and absorptive capacity increases the likelihood for an SME to be involved in physical-end product/service innovations.*

The development and evolution of a firm's knowledge base and absorptive capacity comes about gradually and can be therefore seen as an accumulative and path dependent process (Adams et al., 2006). Path dependent here in its broadest sense means that decisions and actions in the past matter in the long run of the process (Page, 2006) e.g. investing in specialized knowledge has its effect on future absorption of new knowledge. This can be also seen as a danger as path dependency can narrow down the scope of knowledge and eventually lead to inertia within the firm e.g. specialists which are not thinking out of the box anymore (Van den Bosch et al., 2003). Van den Bosch et al. (2003) discuss that too much cognitive proximity can be harmful to learning and innovation. Knowledge accumulation often requires different, complementary sources of knowledge by which novel sources trigger new ideas and creativity. Too much proximity could hamper this process and lead to cognitive lock-in where routines within organizations blur the view on new resources of innovation and market possibilities. The stacking nature of knowledge creation can be detrimental for the well being of an organization something defined as the "competency trap" (Levitt and March, 1996). It is proven to be difficult to unlearn routines and habits that have turned out to be successful in the past yet which have become superfluous over time (Lambooy and Boschma, 2001).

The preceding implies that there would exist an optimal point and a trade-off is made between holding and absorbing knowledge and having an open view to a broad scope of new knowledge. From this reasoning the following hypothesis will be tested:

> *Hyp. 2. There exists an inverted U-shape between the knowledge base and absorptive capacity of an SME and its likelihood to be involved in physical-end product/service innovations.*

A notice to make in the theory of the knowledge base and absorptive capacity in the case of SMEs is that it is predominantly intangible and mostly developed as a by-product of a firms' activities. This can be elucidated by the problem of tacit knowledge as described by Nooteboom (1994). Tacit knowledge, as compared to explicit knowledge, is knowledge acquired by "doing" instead of learning by teaching and can be therefore locked in without the possibility to understand and structurally apply it. Furthermore, holding a sufficient knowledge base or possessing absorptive capacity is most probably not enough to be innovative as the organizational structure of a firm has to allow for this knowledge to flow freely. According to research it is creativity and more specifically organizational creativity that facilitates this process in the context of innovation (Woodman et al., 1993; Amabile et al., 1996).

2.3 Organizational Creativity

2.3.1 Creativity and innovation

It was in the beginning of the 20th century that the term creativity was mentioned in economic theory and more specifically in relation to innovation when Schumpeter (1942) described the phenomenon of "creative destruction". New innovations replace old ones and destroy them from the inside out. Creativity and innovation are assumed to go hand in hand yet it is important to treat them separately. Creativity is the process of original thinking and expression and can come in the form of a new idea; innovation on the other hand is the application of such creative idea within a particular framework. For example, Amabile et al. (1996, p. 1155) suggest that innovation *"begins with creative ideas, creativity by individuals and teams is a starting point for innovation; the first is a necessary but not sufficient condition for the second"*. Literature argues that creativity is a multi-level phenomenon starting with the individual and resulting in organizational creativity through groups and contextual influences (Woodman et al., 1993). Even though creativity is determined predominantly by personal characteristics at individual level, contextual and social influences are acknowledged to be important as well (Woodman et al., 1993; Amabile et al., 1996; Andriopoulos, 2001).

It can be said that on firm level analysis, organizational creativity eventually determines the ability of an organization to convert knowledge into inventions and is in this way vital to the innovative capability of a firm[3].

2.3.2 Individual and organizational creativity

Enhancing creativity within business organizations is a complex and dynamic inquiry. Due to the different organizational settings and continuously evolving external and internal environments, the creative performance of organizations is influenced in many different ways and is consequently as well stimulated as killed by numerous parameters. According to Williams and Yang (1999), the study of organizational creativity is not only about analyzing the creativity of individuals nor the creativity that stems from group work as they assert that the organizational creative process involves numerous links and relationships between variables and therefore different perspectives are ultimately required. Where individual creativity is certainly of a great importance to organizational creativity, the emphasis of organizations on work and outcomes makes creativity in organizations by definition dependent on a collective effort (Scott and Bruce, 1994; Aldrich, 1999). Thus, creative individuals will never be able to complete this on their own and therefore need to be guided, supported and stimulated through efficient practices and routines of organizations. By building further upon the traditional approaches to creativity in which creative individuals were distinguished by their personality characteristics and mental attributes (Barron and Herrington, 1981), voluminous organizational researchers started to focus more on the existence and survival of creative individuals in organizational contexts. As proposed firstly by Woodman et al. (1993), more and more theoretical models were introduced that incorporated on the effects of contextual factors at work and the influences of the social environment on the creative behavior of individuals (Turnipseed, 1994; Ford, 1996; Amabile et al., 1996; Oldham and Cummings, 1996; Shalley et al. 2004).

In this new perspective, Woodman et al. (1993) made a vital contribution when they introduced the multi-level perspective of organizational creativity in which organizational creativity originates out of creative individuals and groups which are subject to social and contextual influences at work.

[3] For a more in depth research on individual and organizational creativity and innovation I refer to J. Kock (2011) who cooperated on the fundaments of this research

In this framework, individual creativity is a function of individual characteristics (knowledge, personality and motivation) and situational and contextual characteristics (e.g., physical environment). Group creativity stems from individual creativity, the combination and interaction of group members (e.g., group composition), the size, norms and cohesiveness of the group (e.g., group characteristics) and contextual influences and organizational creativity originates out of group creativity and dimensions or subsystems in the work environment such as culture, climate and reward systems. Closely related to this and probably one of the most well-known models in this field is the conceptual model of Amabile et al. (1996). The conceptual model originates from an extensive body of research and links organizational creativity to several dimensions in the organization that have a significant influence on the creativity of individuals. Oldham and Cummings (1996) examine the effects of creativity relevant personal (e.g., broad interest, attraction to complexity, intuition, high energy) and contextual characteristics (job complexity and supervisory) on the creativity of employees.

As elucidated above, an extensive body of research is thus available that focuses on the conditions within the work environment that facilitate an employee's creativity. Still, there is a lack of one single and agreed upon theory of organizational creativity and the specific antecedents of creativity inside organizations have not been determined explicitly (Oldham & Cummings, 1996). To provide an initial clarification on the complex inquiry of organizational creativity, Andriopolous (2001) synthesized most relevant writings and theoretical models to address the following two questions: "*how can organizations nurture creativity within their work environment?"* and "*what are the main determinants of organizational creativity?"* The literature review consequently produced five factors which were most frequently acknowledged as stimulants of creativity within different work environments: *Organizational climate, Organizational culture, Leadership and style, Resources and skills, Structure and systems*. Scholars emphasize that the five above mentioned subsystems embedded in organizations instigate conditions that are able to facilitate both the levels of team and individual creativity (Glynn, 1996; Drazin et al., 1999). Addressing these specific features of the work environment can distinguish the organizational context from others in terms of their creative performance. To measure this organizational creativity under this research we will use the conceptual model of Amabile et al. (1996) the KEYS to creativity.

2.3.3 KEYS to creativity

There is a growing tendency to determine the level of organizational creativity by the perceived creative climate of organizations (Isaksen, 2001; Rasulzada, 2007). "*According to contextual theories of organizational creativity, it is the psychological meaning of environmental events that largely influences creative behavior"* (Amabile et al., 1996, p. 1158). In this research, organizational creativity is measured by the KEYS to creativity framework that was developed by the Center for Creative Leadership together with Harvard Business School professor Amabile (1995). The framework is based on an in depth analysis of 12000 managers and employees from organizations all over the world over a 12-year period and distinguishes itself from other frameworks due to the focus on people to people interactions instead of processes and systems. The KEYS framework is established to assess the environment for creativity and innovation for every given organization and focuses on practices of supervisors and managers that have a significant influence on and encourage creativity and innovation.

The model underlying KEYS consists of the following five major conceptual categories: *Encouragement of Creativity, Autonomy or Freedom, Resources, Pressures and Organizational Impediments to Creativity.* Each of these categories is hypothesized to influence creativity and innovation. Extent studies resulted in the KEYS environment scales that were grown out of the five major categories. Conditional results of this studies which correlated positively or negatively with the creative output of organizations are referred to as respectively stimulant scales and obstacle scales. Consequently, the following stimulant and obstacle scales for the five components can be highlighted: *Encouragement of Creativity* stems positively from the conditions of Organizational Encouragement, Supervisory encouragement and Work group supports. Organizational Encouragement addresses that in all the competitive strategies, systems and procedures, organizational leaders must assign top priority to creative efforts. Supervisory encouragement displays whether leaders are able to stimulate the intrinsic motivation of the employees and create an environment in which employees feel appreciated for their contribution to the organization. Work group support revolves around the success of managers to design mutually supportive groups that embody influences from several backgrounds and cultures. Inside these groups, the diversity of perspectives and focus points will guarantee a combination and combustion of revolutionary ideas. The component of *Autonomy or Freedom* originates out of the Freedom scale.

Freedom entails if employees are given latitude in their day to day activities and feel a sense of ownership in the process of problem solving. *Resources* are a function of the stimulant conditions of the sufficient resources scale. Managers carefully need to evaluate how to set time pressures and money rewards. The *Pressure* category originates from the positive outcomes of challenging work and is dampened by the conditions of workload pressure. Challenge demonstrates if managers have been able to select those tasks that cope with the individual's creative thinking skills, domain relevant skills and intrinsic motivation. In this, the stretch of the task is important. Challenging tasks (sufficient stretch) can enhance the individual ability of the employee while, on the other hand, boring tasks (insufficient stretch) can narrow it down. The last component, *organizational impediments of creativity,* is logically influenced by the organizational barriers to creativity.

2.3.4 Hypotheses

The KEYS framework will allow for measuring the underlying conceptual categories of organizational creativity which were just elaborated. The necessity to do so comes from the idea that within the framework of innovation presented in this thesis creativity, and organizational creativity in particular, plays a significant role. The knowledge base and absorptive capacity of the firm on its own, described in the previous part, may not be sufficient to reach an innovative outcome as the organizational structure has to support and enhance this. Organizational creativity is supposed to facilitate the knowledge creation and appropriation process in the context of innovation (Woodman et al., 1993; Amabile et al., 1996). Ideas have to be converted into inventions and inventions on its turn have to lead to innovation. Creativity can nurture this process as it entails original thinking and the creation of new ideas (Amabile et al., 1996) yet also new approaches to handle this new ideas and knowledge (Kao, 1991). Innovation mirrors the inclination of a firm to sustain new ideas, knowledge, novelty and the creative procedures that may result in innovative products/services etc. (Lumpkin and Dess, 1996).

By this reasoning on the concept of organizational creativity and its importance for a firm to be innovative the following hypothesis is drawn up:

> *Hyp. 3. A higher degree of organizational creativity increases the likelihood for an SME to be involved in physical-end product/service innovations.*

Although individual and organizational creativity are supposed to enhance innovative activity, just as with merely having a knowledge base this could turn out to be insufficient. As Amabile et al. (1996) states creativity is a necessary yet not sufficient condition for innovative activity to arise. The locus of knowledge does not have to be the same as the locus of innovation (Grassmann and Enkel, 2004) just as the organizational facilitation of creativity does not need to lead directly to innovation (Huber, 1998; Gurteen, 1998).

Hence, maybe it is the interaction of the knowledge base and absorptive capacity with organizational creativity which should be taken into consideration here, an area untouched in previous literature as stated in the introduction. In example, the realization of an invention stemming from organizational creativity may be seen as vision driven e.g. "let's makes cars drive on water by the end of this decade". Yet, realizing an invention can be as well knowledge driven e.g. using the knowledge and resources that we have to produce an invention (Gurteen, 1998). Research shows that the degree and variety by which an individual is exposed to information and knowledge is of importance to that individual's creativity (Sternberg and Lubart, 1995; Amabile, 1996). On the other hand, it is the organizational environment as elaborated before which has to allow for this knowledge to be appropriated. Creativity is the starting point of innovation by generating new ideas (Amabile et al., 1996) yet may be insufficient to innovate because of the lack of relevant knowledge and information which could lead to re-inventing the wheel over and over again (Koellinger, 2008). Moreover, it may be the combination of knowledge and creativity (Gurteen, 1998) or organizational learning and creativity (Huber, 1998) which leads to innovation. From the preceding two parts we can therefore hypothesize that:

> *Hyp. 4. The interaction between the knowledge base/absorptive capacity and organizational creativity will increase the likelihood for an SME to be involved in physical-end product/service innovations.*

2.4 Entrepreneurial Capital

2.4.1 Entrepreneurship and innovation

Whereas the previous two chapters elaborated on the expected determinants organizational learning and organizational creativity within the innovation process, this part discusses the third building block of entrepreneurial choice or entrepreneurial capital. The literature on innovation and again the definitions stated in chapter one both acknowledge the importance of creating inventions and commercializing them within the innovation process (Feldman, 1994; Krebbekx et al., 2006). An invention does not equal an innovation as it has to be appropriated and brought on the market (Feldman, 1994; Adams et al., 2006). Hence, entrepreneurship can be viewed as the link which brings creativity, knowledge and innovation together for commercialisation of the results (Schoonhoven and Romanelli, 2002).

The importance of entrepreneurship regarding innovation has been acknowledged in the past decades and more specifically the importance of entrepreneurship in the context of SMEs (Audretsch and Thurik, 2004; Acs and Audretsch, 2005). Audretsch and Thurik (2004) argue in their model of the entrepreneurial economy (dominated by SMEs) that growth, and thus innovation, is not just dictated by the production factor of knowledge yet also by a different, but complementary, factor which is overlooked: entrepreneurial capital, or the ability to be involved in and provoke entrepreneurial activity.

Literature shows that several studies have try to cope with the structure, process and strategy of either innovation or entrepreneurship (Littunen, 2000) and that again other studies have dealt with the conceptual relationship amongst the two (Schumpeter, 1934; Drucker, 1994). One way of viewing entrepreneurship and innovation is that they are practically identical to each other. From the organizational approach the field of entrepreneurship can be defined by the study of *"how, by whom and with what consequences opportunities to produce future goods and services are discovered, evaluated and exploited."* (Shane and Venkataraman, 2000, p. 218). Seizing this exogenous opportunity can be as well perceived as innovation as entrepreneurship.

Contrary to the view of Shane and Venkataram (2000) which ought that opportunities exists exogenously, Acs and Audretsch (2005) dispute that opportunities can exist endogenously. To elucidate on this, Acs and Audretsch (2005) argue that firms exist exogenously and become involved in the persecution of new knowledge to generate endogenous innovative activity. One way to explain this difference in opinions is that the former view comes from the literature of entrepreneurship and takes the individual as the decision making unit of analysis whereas the latter view comes from the economics of innovation and takes the firm as the decision making unit of analysis (Acs and Audretsch, 2005).

Partially in the same line of argument Audretsch and Thurik (2004) propose a shift in the unit of analysis from the exogenously assumed firm towards the individual with endowments of new knowledge. In addition, by this shift entrepreneurship is presumed to serve as a transmission mechanism for knowledge spill-over. It is not obvious that R&D or any other form of knowledge always spills over solely due to its existence (Audretsch and Keilbach, 2003). With the shift of the unit of observation from the firm to the individual the question becomes: how can an agent with a given endowment of (new) knowledge be compensated for this knowledge appropriately. When the knowledge worker is not heard by the incumbent organization and loyalty is weak or power distance and inequality is high, the valuable information can get lost or an employee may exit the firm where the knowledge is created to start a new firm (Hirschman, 1970; Hofstede, 2001). Behold, due to this spill-over process the knowledge and the worker embodying this are now exogenous and the firm is created endogenously by the worker's effort to reimburse his value of knowledge by innovative activity (Acs and Audretsch, 2004).

2.4.2 Intrapreneurship

When this worker would stay within the ancestry organization and would engage in entrepreneurial activity, given sufficient support, this would classify as intrapreneurship or corporate entrepreneurship with an interchangeable use of the two terms. Corporate entrepreneurship in its broadest sense is the creation of new organizations by an organization (Sharma and Chrisman, 1999) and is firstly developed under the theoretical construct of entrepreneurship within large organizations (Drucker, 1994). Therefore, SMEs would be too small to be associated with corporate entrepreneurship as we just argued that it is the entrepreneurial activity failing in a larger firm leading to this SME to arise. However, at the organizational level new firm formation can be viewed in relative terms.

Antoncic and Hisrich (2003) argue that entrepreneurship within organizations is a continuum ranging form the less to the more entrepreneurial firms[4]. A firm can be entrepreneurially-challenged or conservative meaning that the organization is risk-averse, non-innovative and reactive yet a firm can be also entrepreneurial meaning that the organization is risk-taking, innovative and proactive (Covin and Slevin, 1989; Brazeal and Herbert, 1999).

Dealing with entrepreneurial behaviour in as well SMEs as large firms Antonic and Hirsch (2003) find intrapreneurship a more appropriate term than corporate entrepreneurship and define this as: *"entrepreneurship within an existing organization, referring to emergent behavioural intentions and behaviours of an organization that are related to departures from the customary"*(Antonic and Hirsch, 2003, p. 9). Moreover, intrapreneurship goes on within existing firms regardless of their size as intrapreneurship does not only refer to the creation of new enterprises yet also to other innovative practices and orientations e.g. development of new products/services and strategies. Antonic and Hirsch (2003) contrast intrapreneurship with similar management concepts as organizational learning and organizational innovation and come to an eight-dimension intrapreneurship concept which integrates previous categorizations relevant for firm level entrepreneurship from different literature (Covin and Slevin, 1989; Zahra, 1991; Knight, 1997). These eight dimensions are *new ventures, new businesses, product/service innovativeness, process innovativeness, self-renewal, risk-taking, pro-activeness and competitive agresiveness.*

In a nutshell, the eight dimensions denote the following: *new ventures* is the formation of new and (semi) autonomous entities e.g. units and firms. This dimension includes autonomy which was previously seen as a characteristic of the individual yet now captured at the organizational level. The dimension *new business* stresses the engagement within the existing organization into new businesses that are related to the firm's products and/or markets. *Product/service innovativeness* naturally emphasize the creation of new products/services just as *process innovativeness* regards the innovations in production processes and techniques. The *self-renewal* dimension accentuates reorganization, strategy reformulation and organizational change. *Risk-taking* is the organizational commitment of resources in the chase for new opportunities with the possibility of losses when taking quick bold actions.

[4] Of course a continuum has absolute terms which do not actually exist in real life but are there for a better understanding.

The *pro-activeness* dimension considers top managements' orientation for initiative taking and pioneering. *Competitive aggressiveness* concerns the firm's aggressive attitude towards competitors. Firm-level entrepreneurship dimensions do not only differ from each other yet also relate and in such are forming the basis of intrapreneurship (Antonic and Hirsch, 2003).

2.4.3 Synergy between entrepreneurship and innovation

Noticeable in the previous part is that where some research reckons that entrepreneurship holds an organizational component and implicates the creation of new ventures (Acs and Audretsch, 2004), others argue that entrepreneurship is not solely represented by the individual starting a new venture yet entrepreneurship can be viewed within an organizational framework as well (Antonic and Hirsch, 2003). This implicates that entrepreneurship and innovation should not be restricted to the individual nor the industrial level yet also the organization as an entrepreneurial entity should be considered.

Regarding the individual level in the context of entrepreneurship and innovation within SMEs it should be noted that entrepreneurs are different from small business owners. Small business owners are primarily focused to secure their income and meet their direct needs without the necessity to engage in innovation, whereas entrepreneurs have a higher motivation for achievement and risk taking behaviour pursuing innovation and change (Steward et al., 1998). Other research tries to link firm innovation typologies to the characteristics of the founder and even beyond this others link the characteristics of the founder to the impact of the innovation e.g. incremental or radical innovation (Hoffman et al., 1998). Again, on the level of the entrepreneur, some make a distinction between the firm-organizing entrepreneur who creates, organizes and operates a firm and the innovating entrepreneur who transforms inventions into economically viable products (Baumol, 1968). A reoccurring term in entrepreneurial literature as well on industry as on firm level is risk and uncertainty. To innovate means to explore new opportunities and markets hence there is a limited amount of information about e.g. consumer behaviour and potential competitors. Whereas the (imitative) small business owner operates in established markets involving little or no risk and uncertainty the (innovative) entrepreneur needs the courage to explore unknown territory involving Knightian uncertainty (Knight, 1921) and risk. Although risk is an ambiguous characteristic it is worthwhile to take into consideration regarding entrepreneurship and innovation.

The organizational level in the context of entrepreneurship and innovation is elaborated on already previously. The conceptual relationship between the individual entrepreneur and innovation is touched upon as well, on micro and macro level. There is most likely a synergy to be found between entrepreneurship and innovation (Zhao, 2005) meaning that these terms are positively related to each other and should be regarded as dynamic and holistic processes within entrepreneurial and innovative organizations. The interaction of entrepreneurship and innovation helps an organization to flourish; the interaction of the terms are complementary and not confined to the initial stages of new ventures (Zhao, 2005).

2.4.4 Hypotheses

Thus, entrepreneurship can be viewed in the light of innovative activity both on individual as on industrial level. Moreover, entrepreneurship should be regarded as a dynamic and ongoing process on organizational level as well even within SMEs. The occupation of an entrepreneur is to apply knowledge and to create products for human consumption and by this creating wealth by giving factors of production a utility they did not have before (Say, 1971). Entrepreneurial behaviour leaves the status quo, striking off existing processes and replacing them by new technologies that create new opportunities and foster growth (Schumpeter 1934, 1939).

By this reasoning on the interaction of individual and organizational entrepreneurship and innovation going on within firms regardless of their size the following hypothesis is drawn up, note that the hypothesis consists out of two parts regarding individual and organizational entrepreneurship :

> *Hyp. 5.a. A higher level of individual entrepreneurship increases the likelihood for an SME to be involved in physical-end product/service innovations.*

> *Hyp. 5.b. A higher level of organizational entrepreneurship increases the likelihood for an SME to be involved in physical-end product/service innovations.*

Obviously, as closely as individual, organizational entrepreneurship or intrapreneurship is related to innovation, this research concerns the entire process from idea to commercialization and therefore again this presumed determinant of innovative output in SMEs could turn out to be insufficient.

The importance of the knowledge base and absorptive capacity of a firm has been elaborated on, and within the context of the innovation process the importance of organizational creativity as well. As stated before, within this innovation process an idea has to be created and refined to an invention and finally brought on the market as an innovation (Feldman, 1994; Adams et al., 2006). Individual and organizational entrepreneurship could contribute the knowledge base similar to absorptive capacity as entrepreneurship involves recognizing, capturing and appropriating ideas (Johnson, 2001). In addition, the dimensions making up the framework of organizational creativity such as risk, freedom and challenge (Amabile, 1996; Andriopolous, 2001) overlap with the characteristics and dimensions of respectively individual and organizational entrepreneurship.

The capability to invent and to recognize new business opportunities may not necessarily exist within the same person as many inventors do not tend to actively patent or commercialize their ideas and work. However, many of the most successful inventors were both entrepreneurial and inventive (Khan and Sokoloff, 1993). In the same line of argument, creating and holding knowledge may be insufficient for an organization to produce and profit from innovations yet having an entrepreneurial spirit should be taken into account as well. In addition, creativity can be viewed as part of the process by which ideas are generated, innovation as the process by which this creativity is implemented and entrepreneurship as the individual and organizational process by which innovation takes place (Kao, 1991). Moreover, entrepreneurship combines creativity and innovation towards commercialization ends by means of networking (Schoonhoven and Romanelli, 2002).

By this reasoning the following hypotheses are drawn up:

> *Hyp. 6. The interaction between the knowledge base and absorptive capacity of a firm with individual and organizational entrepreneurship, increases the likelihood for an SME to be involved in physical-end product/service innovations.*

> *Hyp. 7. The interaction between organizational creativity and individual/organizational entrepreneurship increases the likelihood for an SME to be involved in physical-end product/service innovations.*

3. Empirical part

3.1 Sample information

3.1.1 Data collection

The data collection and herewith the Master thesis is the extension of a Scientific Research Project which was conducted for study association EUREOS among Dutch SMEs. Together with a fellow student, J. Kock, involved in this project we extended the research to use for our thesis and started the data collection in April 2010. After some literature review it became evident that collecting a representative group of 60 innovative SMEs would be a hard task. We decided to use a platform from which we knew that the SMEs would be both diverse and innovative namely the Dutch Syntens innovation platform. This platform each year awards the most innovative SMEs from a constructed list of 100 firms. The innovative organizations participating in this award are judged on their impact and contribution to society, originality and applicability, commercialization of the innovation and degree of protection[5]. As we expected that these firms would be flattered to participate the aim was to gather our 60 innovative SMEs from the 100 firms selected in 2010. These 100 SMEs were contacted by email with the request to participate in our research.

The data was collected through an internet based survey (Global Park software), which we were allowed to use in our project, and offered us several advantages in the construction of our survey e.g. different paths could be chosen omitting question which were not relevant for the firm and bringing down response time. The average response time of the innovative SMEs through a link by email was 15 minutes.

After two weeks the 100 SMEs received a follow up mail and the majority agreed to fill in the questionnaire by the end of the week. However, by May 2010 only 10 SMEs managed to complete the survey and we decided to contact the 100 innovative SMEs from the year 2009 as well. This increased our participants to 15 firms by June and in the same month another 200 SMEs from the 2007 and 2008 lists were send an email with a link to the survey. In July 2010 a total of 400 SMEs was contacted and 30 SMEs filled in the full survey.

[5] For more information visit: http://www.syntens.nl/innovatietop100/Pages/MKB-Innovatie-Top-100-home.aspx

The aim was to gather the data in one manner, namely by email, not to influence the response yet due to some severe delay a different approach was used after the holidays in September. We decided to contact the SMEs personally by phone reminding them to fill in the survey and managed to do this directly by phone for most of the firms. Due to this new approach which increased the response time to an average of 30 minutes by phone a group of 60 presumably innovative SMEs was collected at the end of September 2010 with an average response rate of 15%.

Hereafter, data had to be collected from another 60 SMEs representing the control group. The aim was to gather data from firms with the same characteristics as the 60 "innovative" firms. The 60 innovative firms were scattered throughout the Netherlands and very diverse in industries e.g. ranging from food related firms to consultancy firms. As we were behind schedule due to the slow response of the firms the decision was made to contact SMEs from the Gouden Gids randomly yet with a focus on Rotterdam and surroundings. Reason for this was the presumed association with the Erasmus University and the fact that we could invite them for the symposium on innovation which we arranged during our project and in this way encourage them to participate. To our delight we noticed that these firms were willing to cooperate more efficiently and by the half of October we gathered data from 30 SMEs. To speed up the process again we contacted the remaining firms by phone and at the end of October 2010 we had data from 60 SMEs from a pool of 300 firms with a response rate of 20%. In total, 120 SMEs participated in our research from a pool of 700 firms leaving us with an average response rate of 17.1%.

The next important thing to do was separating the innovative from the non-innovative SMEs. Actually, this was already accounted for during the gathering of the data as there was a possibility that SMEs contacted from outside the innovative platform lists could be innovative as well. In addition, although the Dutch Syntens innovation lists are constructed regarding some innovative benchmarks we wanted to measure the degree of innovativeness and exclude purely imitative firms within this group. Our survey contained the questions whether the firm under scrutiny was involved in any product or service innovation within the last 3 years and if so whether the innovation was successfully commercialized.

In addition, to measure the degree of innovativeness and double check our data we included three questions from the Global Entrepreneurship Monitor (GEM)[6] as presented in section 3.2.

3.1.2 Data information

The total sample consists out of 120 SMEs of which 60 classify as innovative and 60 as non-innovative firms. That is, 60 SMEs were involved in innovative activity within the last 3 years and successfully commercialized their innovation. Furthermore, table 2 shows that the Innovative and Non-innovative firms do not differ that much concerning their general characteristics. The innovative firms exist on average 23 years and employ on average 18 individuals. The non-innovative firms exist on average 19 years and employ on average 16 individuals. In addition, 72% of the innovative firms are independent compared to 75% of the non-innovative firms. Notable is that the innovative firms do show a larger growth in their turnover over the last two years and most of the innovative firms (48%) belong to the Industry sector. However, the last is not that surprising as we are dealing with mostly tangible product innovations in this research. It has to be noted that the figures in table 2 are averages from our dataset which include some outliers on size and age. When controlling for these few firms the averages are in accordance with the country averages as given by the European Commission SME monitor[7]. Among others, these figures show that 91.8% of Dutch SMEs consist out of micro firms employing 10 or less workers and thereby accounting for 29.7% of the total employment. Furthermore, EU stats show that approximately 25% of the SMEs are dependent on a sister organization or larger firm which coincides with the figures from our dataset.

Table 2: General information on the dataset. The last 5 variables being the industry sectors.

	Total	Innovative	Non-Innovative	p-value
Number	120	60	60	
Size	17 employees	18 employees	16 employees	0.363
Age	21 years	23 years	19 years	0.373
Independence	73%	72%	75%	0.683
Growth	2.1	2.4	1.9	0.005
Industry	35%	48%	22%	0.002
ICT	18%	18%	18%	1.000
Health	9%	7%	12%	0.347
Advisory	18%	15%	22%	0.350
Others	19%	12%	27%	0.037

[6] www.gemconsortium.org

[7] http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/pdf/final/sba_fact_sheet_netherlands_en.pdf

The questions concerning the degree of innovativeness and their related answers are depicted in the figures beneath. Note that these percentages only relate to the innovative group of 60 SMEs as the control group exists out of 60 non-innovative SMEs.

Figure 1: Product new to customer

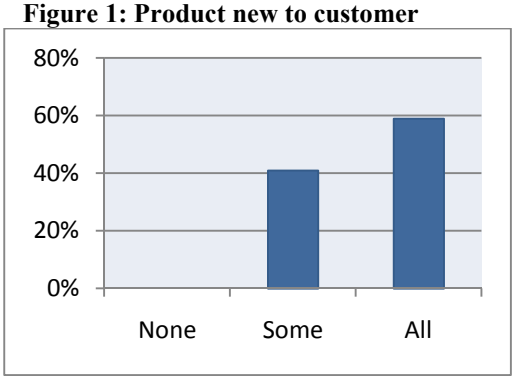


Figure 2: Competition on the market

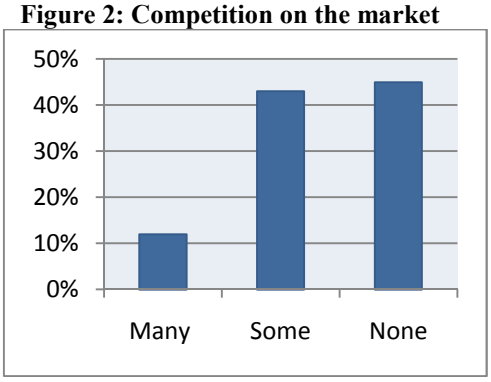
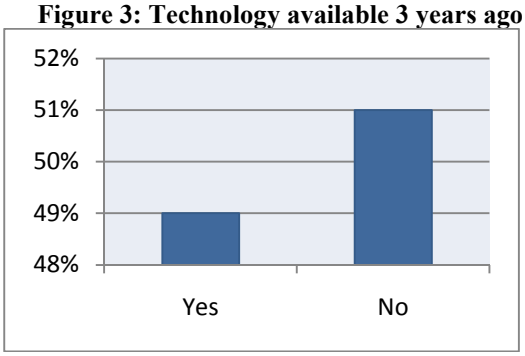


Figure 3: Technology available 3 years ago



The figures show that within the innovative group there is not one purely imitative firm as the product or service is always new to some of the customers (Fig. 1). Besides, it is visible that more than half of the innovations encompass a technology which was not available yet 3 years ago (Fig. 3) and there is little to no competition in the market (Fig. 2).

3.2 Variables

3.2.1 Dependent variable

As we are looking for the determinants of innovative activity our reference group should be an innovative firm. In section 2.1 it is argued that a direct measurement of innovative output is preferred over patent application/citation and R&D(input) measurement methods (Kleinknecht et al., 2002; Acs and Audretsch, 2005; Hall, Jaffe and Trajtenberg, 2005).

In addition, commercialization of the innovation is considered an important aspect with regard to the appropriation issue and considered as part of the innovation process (Feldman, 1994; Adams et al., 2006).

To accomplish this we do research on innovative SMEs from the Dutch Syntens innovation platform which are selected on their innovative performance and commercialization. Besides, we asked them the questions whether they were involved in and had commercialized any product or service innovation within the last three years. The specific choice of product/service innovations was made deliberately as this is less ambiguous than e.g. social innovations and specification of the type of innovation could contribute to a better understanding of its determinants (Oslo Manual, 2005). To exclude purely imitative innovations and for the use of description the following three questions in table 3 from the Global Entrepreneurship Monitor (GEM) are used.

Table 3: Survey questions on innovativeness

Survey question	Answer categories
T – "Were the technologies or procedures required for this product or service generally available more than three years ago?"	T1 – Yes T2 – No
C – "Will all, some or none of your (potential) customers perceive this product or service new and unknown?"	C1 – All C2 – Some C3 – None will consider this new and unknown
M – "Right now, are there many, few or no other competitors offering the same products or services to your target group of customers?"	M1 – Many competitors M2 – Few competitors M3 – No competitors

Source: Global Entrepreneurship Monitor (GEM)

When answering T2, C1 and M3 this indicates that we are dealing with a radical product or service and thus an innovative SME. On the other hand, when answering T1, C3 and M1 the product or service is considered purely imitative. Any other combination of the answers depicts a classified continuum between incremental and radical innovations (see section 3.1 for percentages). When classifying our dependent variable we sorted our data on the involvement and commercialization of any product or service innovation and excluded purely imitative innovations from the innovative group of SMEs. When fulfilling these requirements an SME is coded as innovative (Yes/No), hence a binary dependent variable.

3.2.2 Explanatory variables

The questionnaire was designed to test the hypotheses in chapter 2, the variables are deduced from the hypotheses and their measurement is backed up by literature where necessary and possible. The first explanatory variable we need to test the hypotheses is therefore the knowledge base of the firm (Know_Base). The knowledge base of SMEs is considered to consist out of internal and external knowledge which are regarded complementary (Saviotti et al., 1998; Caloghirou et al., 2004). The internal knowledge can be further divided into generic knowledge and absorptive capacity yet both can be viewed as overlapping. Considering the generic knowledge firms were asked to answer the questions whether they have an innovation and/or R&D department which could both be answered by yes or no. In addition, the question was asked if the firm allocates tasks towards R&D ends (yes/no). Regarding the absorptive capacity firms were asked to report their percentage of R&D over sales which is divided into four categories to confine variance in answers by guessing.

The other questions considering absorptive capacity are aimed at the (informal) character of human capital and asked the firm about the average educational level (four categories; again confining variance) and whether they employ QSEs (yes/no). Regarding the external knowledge firms were asked if they outsource R&D and/or receive/buy knowledge from others (both yes/no). Additionally, firms could indicate whether they hold external network linkages ranging from a score of 1 to 4 i.e. universities, government, other firms or others. Table 4 depicts the different items for the construct of the variable Know_Base with (some of) their corresponding literature sources. The construct shows a respectable alpha-coefficient of .69. Furthermore, the construct is a weighted enumeration of all the items. The questions with yes/no are added and the three categorical questions ranging from 1-4 are first divided by two. This is done intuitively as all the items can be viewed as of equal importance. Moreover, to measure the assumed inverted U-shape the variable Know_Base is squared to add in the regression which is done commonly when detecting such curve linear relationships.

Table 4: Construct of the variable Know_Base.

Items	Derived from	Variable
Internal knowledge:		
Does the firm has an innovation and/or R&D department (F)	*Oslo Manual, 2005*	**Knowledge Base**
Does the firm allocates tasks towards R&D ends (I)	*Malerba, 2005; Oslo Manual, 2005*	
What is the R&D intensity i.e. R&D/Sales (A)	*Cohen and Levinthal, 1990; Adams et al. 2006*	**α = .69**
What is the average educational level and does the firm employ QSEs (A)	*Hoffman et al., 1998; Vinding, 2004*	
External knowledge:		
Does the firm outsource R&D and/or receives/buys knowledge (F)	*Own addition (Oslo Manual, 2005)*	
Does the firm hold external knowledge linkages with e.g. universities (I)	*Rothwell and Dodgson, 1994; Von Hippel, 1994*	

The second variable we need to test for our hypotheses is that of organizational creativity (Org_Crea). Here, organizational creativity is measured by the KEYS to creativity framework that was developed by the Center for Creative Leadership together with Harvard Business School professor Amabile (1995).

The framework is based on an in depth analysis of 12.000 managers and employees from organizations all over the world over a 12-year period and distinguishes itself from other frameworks due to the focus on people to people interactions instead of processes and systems. The KEYS framework is established to assess the environment for creativity and innovation for every given organization and focuses on practices of supervisors and managers that have a significant influence on and encourage creativity and innovation. Questions from the KEYS framework were included in the survey (see appendix) making up six positively and two negatively related KEYS to creativity. The positive KEYS are: organizational encouragement, supervisory encouragement, workgroup support, freedom, resources and pressure. The negative KEYS are: organizational impediments and barriers[8]. All the creativity questions could be answered on a 1-5 Likert scale. To construct the Org_Crea variable the two negative KEYS (and other reversed questions) were reversed (back) and added up to the positive questions after which the average was taken. The construct shows a strongly respectable alpha-coefficient of .87 which is not that surprising given the tested validity of the KEYS framework. Table 5 shows the construct of Org_Crea.

[8] For a more in depth research on individual and organizational creativity and innovation I refer to J. Kock (2011) who cooperated on the fundaments of this research.

Table 5: Construct of the variable Org_Crea.

Items	Derived from	Variable
Positive KEYS (6+)	*Amabile, 1995; Amabile et al., 1996; Center for Creative Leadership*	**Organizational Creativity**
Negative KEYS (2-)		**α = .87**

The last variable we need in our research is one representing the level of individual and organizational entrepreneurship which is called entrepreneurship capital (Entr_Cap). Note that this is not in accordance with the previously stated hypotheses 5a and 5b under the theoretical part. Unfortunately our dataset did not contain enough responses from as well the founders as the managers and employees working within the same firm to measure both individual and organizational entrepreneurship adequately. Therefore, we combined the data available to make one variable: Entr_Cap or Individual/Organizational Entrepreneurship. According to literature there is a synergy to be found in the relationship between entrepreneurship and innovation which should be viewed as a holistic process (Zhao, 2005; McFadzean et al., 2005). In addition, entrepreneurship at the organizational level, intrapreneurship, is also argued to exist within SMEs (Antonic and Hirsch, 2003; McFadzean et al., 2005). Literature reviews on these topics imply that there is a missing link when attempting to measure the level of entrepreneurship within firms in relation to innovation (Zahra, 1995; McFadzean et al, 2005). It is assumed that next to external determinants, intrapreneurship also entails various internal attitudes and actions enhancing the firm's ability to take risk, seize opportunities and innovate (Zahra, 1995). Indeed, a literature review of McFadzean et al. (2005) shows that entrepreneurial actions, vision and attitudes are of importance and should be taken into account. In this research entrepreneurship capital is measured by attitudes and actions with risk being separated from attitudes due to its ambiguous character and measurement. Entrepreneurial attitudes can be e.g. the motivation to engage in entrepreneurial activity, risk taking behaviour, confidence and willingness to fail (Steward et al., 2003; Ensley et al., 2000). Questions relating to these items are e.g. whether the respondent thinks to have sufficient knowledge, experience and skills to run a business (measuring confidence) and whether the respondent sees good opportunities in his surroundings.

Entrepreneurial actions are somewhat less defined and here measured as engagements into entrepreneurial activities e.g. whether the respondent has(is planning to) started(start) a business or whether the respondent is financing a business. The questions measuring attitudes and actions are taken from the Global Entrepreneurship Monitor where applicable. Risk (downside risk) could be measured by the attitude question whether fear of failure would prevent the respondent from starting a business yet it has turned out that this question does not capture risk (Koellinger, 2008). Therefore, risk is here measured by the SOEP[9] risk score ranging from 0 being completely risk-averse to 10 being totally risk loving. The variable Entr_Cap is constructed by a weighted enumeration of the separate items. The 5 point Likert-scale attitude questions and the risk score are first divided by five before adding to the actions questions (yes/no). This is done intuitively on basis of the importance of the separate items. The variable shows a respectable alpha-coefficient of .70.

Table 6: Construct of the variable Entr_Cap.

Items	Derived from	Measured by	Variable
Attitudes	*Steward et al., 2003; Ensley et al., 2000; McFadzean et al., 2005; Global Entrepreneurhip Monitor*	*Six questions 5 point Likert scale (GEM)*	**Entrepreneurship Capital** **α = .70**
Actions		*Five yes/no questions(GEM)*	
Risk		*SOEP risk question scaling from 0-10*	

3.2.3 Control variables

To check for the robustness of our data and to capture the distinct effect of the explanatory variables the following control variables are added to the regressions: size, age, industry and independence. The first two control variables size and age will be described simultaneously as they are closely related to each other.

Innovative activity is supposed to enhance the probability of survival for firms yet there are more factors which could increase this probability. From an internal perspective of the firm these factors are predominantly assumed to be size and age, both increasing the survival of firms in the market (Dunne and Hughes, 1994). Empirical studies show that the chances of survival increase with size and age yet at a decreasing rate.

[9] According to the German Socio-Economic Panel Study (SOEP) this question measures risk taking behaviour more efficiently than separate questions concerning health and gambling.

In addition there is a positive interactive effect to be found between age and size: the chances of survival increase with age more rapidly for larger firms and vice versa (Evans, 1987; Hall, 1987). In the same line of argument, age and size may have influence on the innovative performance of a firm and in this case the SME. Research shows that both age (Audretsch, 1995; Klepper, 1996) and size (Damanpour, 1992; Audretsch, 1997) affect the innovative performance of SMEs although the effects are sometimes ambiguous. For example, younger firms are regarded to be e.g. more flexible, risk- and opportunity seeking as compared to larger bureaucratic firms which on their turn have e.g. better developed routines and network/distribution channels. For SMEs, it can be said that with an increasing age, size will increase as well and a firm could reach its minimum efficiency scale (Audretsch, 1997) leading to a better innovative performance. Because both our groups consist out of SMEs these effects are expected to be marginal yet they are still included. Age and size are continuous variables depicting respectively the years of existence and number of employees in our sample of Dutch SMEs.

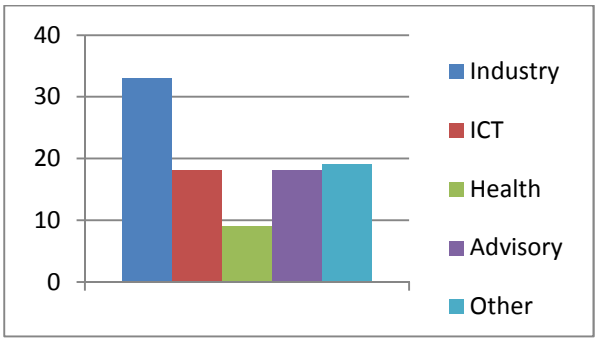
Next to size and age the respondents were asked whether they are part of a larger cooperation or whether they operate independently. The reason to include this control variable is that when an SME is part of a larger cooperation it can also profit from scale economies present under such a construct e.g. distribution/networking channels and a larger bargaining power with suppliers. On the other hand, being independent means having a larger autonomy over the organization and being able to make decisions swiftly as an alternative to reduce average costs (Teece, 1993). Independence is a categorical dummy variable taking the value 1 when the SME is independent and 0 when the SME is dependent.

The last control variable used to further purify the effect of the explanatory variables is the type of industry in which the SME operates. Most of the research on the determinants of innovative SMEs is done within technology abundant sectors as these are more commonplace industries for innovations to take place (Hoffman, 1998). It is likely that some industries have less expensive or more accessible innovations than other industries. The respondents were asked to indicate which sector they belong to and based on similarities of their true sector an industry classification was constructed using industry codes (SBI) from the Dutch Central Bureau for Statistics (CBS) [10].

[10] For more information a reference is made to Standaard Bedrijfs Instelling 2008 (CBS, 2008).

The four largest industries were selected: industry, ICT, health and advisory and the remaining part was classified as "others", see figure 4. To include this variable, dummies were made for each industry taking the value 1 when an SME belonged to this industry and 0 when the SME did not. The category "other" is used as a reference category within the regressions as this category is of least importance for interpretation.

Figure 4: Distribution of the sectors in the total sample.



3.3 Results

3.3.1 Preliminary results

First we will look at the descriptive statistics concerning the knowledge base coming out of our data. Table 6 shows us the different mean scores on the items making up the Know_Base construct with their according t-statistic for both innovative and non-innovative SMEs. The innovative SMEs score significantly higher on the questions:

- Having an innovation department (in percentages); - R&D over sales level (in four categories); - R&D tasks within the organization (in percentages); - The average education level (in categories); - External R&D activities (in percentages); - External linkages (Ranging from 1-4).

The non-innovative firms do not score (significantly) higher on any question. Only the question whether the SME buys external R&D/knowledge is scored upon equally with a mean of 30%. The innovative SMEs score over twice as much on having R&D tasks somewhere within the organization (70% against 30%) indicating a high level of informal R&D.

To illustrate the response of the firms concerning R&D and knowledge in qualitative terms: concerning the question whether the firm has patented any ideas/innovations answers ranged from *No, the market and technologies are changing to swiftly* to *Yes, our patents are worth several millions!* This shows a large difference in patenting behaviour and indicates that successful innovative SMEs do not always have to patent their innovations. Regarding the question whether the firm has an R&D department answers ranged from *Yes, with 4 employees* to *No, yet R&D is manifested in every part of our organization*, hence informal R&D. Furthermore, there are no surprising or notable scores in accordance with literature.

Table7: Descriptive statistics Know_Base

	Innovative		**Non-innovative**
	Mean	t-statistic	Mean
Internal knowledge:			
Inn. Department	30%	3.00*	10%
R&D department	30%	1.26	20%
R&D/Sales	2.2	8.04**	0.5
R&D tasks	70%	4.74**	30%
Education level	2.8	3.34**	2.1
QSE's	40%	0.57	30%
External knowledge:			
External R&D	1.4	3.01*	0.7
Buying R&D	30%	0.39	30%
Linkages	1.9	5.95**	0.7

The second construct and its items is that of Org_Crea. All the questions could be answered on a 5 point Likert-scale. The innovative SMEs scored a significantly higher mean of 4.1 compared to 3.1 on the positive KEYS' average. The non-innovative firms scored a significantly higher mean of 3.4 compared to 2.5 on the negative KEYS' average. The positive KEYS can be further divided into 6 categories (Organizational encouragement, Supervisory encouragement, Workgroup support, Resources, Challenge and Freedom) all on which the innovative firms scored higher. Notable here is that the innovative firms scored only slightly higher on the Resources questions, 3.8 compared to 3.6 and that this difference was not significant. This can be attributed to the questions: *In general I have access to all necessities to complete my work?* And *In general I have sufficient funds to complete my projects?* both on which the non-innovative firms scored higher yet not significantly.

The negative KEYS can be further divided into 2 categories (Workload pressure and Organizational impediments) with its according questions all on which the non-innovative firms scored higher except for the following question: *Individuals within the organization are very occupied defending their territory?*. Innovative firms scored higher on this question, 2.3 compared to 2.2 yet this is not significant. Obviously it is assumed to be in the firm's benefit regarding its innovative performance to score high on the positive and low on the negative KEYS categories and questions. The outcomes depicted in table 7 are significantly in favour of the innovative firm and therefore not that surprising. This could indicate a great importance of organizational creativity as a determinant for innovative outcomes.

Table8: Descriptive statistics Org_Crea

	Innovative		**Non-innovative**
	Mean	t-statistic	Mean
Positive KEYS	4.1	15.73**	3.1
Negative KEYS	2.5	-8.72**	3.4

Table 8 depicts the mean scores and t-statistic on the items constructing Entr_Cap both for innovative and non-innovative SMEs. The innovative firms score significantly higher on entrepreneurial attitude (measured on a 5 point Likert-scale), 4.1 compared to 3.6. In addition, the innovative firms are willing to take more risk with a significant difference of 7 compared to 5.7 on the SOEP risk score question. However, the non-innovative firms score surprisingly higher on entrepreneurial actions (measured by six yes/no questions on actions with a total score of 6 to achieve), 2.4 compared to 2.2 yet this difference is not significant. This surprising higher score on entrepreneurial actions is caused by the question: *Are you starting up a business in the near future?* On which 70% of the non-innovative firms answered yes compared to 33% of the innovative firms. And the question: *Do you finance other start up businesses?* On which 40% of the non-innovative firms answered yes compared to 23% of the innovative firms. Notable is that regarding the question: *Are you starting up a business from within your current organization?* 30% of the innovative and 20% of the non-innovative firms answered yes, indicating intrapreneurship within SMEs. Entrepreneurial attitude entails five questions concerning the attitude towards entrepreneurship on a 5 point Likert-scale all on which the innovative firms scored higher.

Table9: Descriptive statistics Entr_Cap

	Innovative		Non-innovative
	Mean	t-statistic	Mean
Entrepreneurial action	2.2	-0.72	2.4
Entrepreneurial attitude	4.1	4.75**	3.6
Risk	7.0	3.86**	5.7

Next to comparing the innovative and non-innovative group, a correlation matrix is depicted in table 9 to look for interdependency between variables which are most important. There are quite a lot of high correlations visible yet this is not that surprising since all of the three interaction terms are included. The independent variables (except for Entrepreneurial Capital) and interaction variables correlate high with the dependent variable (innovative) which is promising for our regression. The only notable fact is that Entr_Cap correlates negatively with Know_Base. The control variables are not added into the table since there were no significant or notable facts to address. In addition, the correlations between all of the questions making up our variables are checked for and no worrying effects were found. The table also includes VIF-scores to check for Multi-collinearity. At first some of the VIF-scores were too high (5 and above) indicating signs of multi-collinearity. This was not surprising and is common since the squared term of Know_Base and all the interaction terms include double variables. However, to get a reliable outcome of our data for interpretation it is better to have no multi-collinearity between the independent variables and interaction terms. Therefore, each interaction is tested in a separate model including the other independent variables.

In addition, in an attempt to get rid of the multi-collinearity the variables in these models are centred which is a method used to overcome this problem. To centre the variables means subtracting the mean of that variable from each score of that variable, this might not always overcome multi-collinearity yet always enhances the interpretability of the outcomes (Aiken and West, 1991). The Know_Base and the squared term of the Know_Base are left un-centred as they are used in model 1 to test for an inverted U-shape hence the higher VIF-scores are not worrying.

Table10: Correlation matrix and VIF-scores.

	Inn.	Know	Crea	Entr	$Know^2$	Kno*Crea	Kno*Entr	Ent*Crea	VIF-score
Innovative	**1**								
Know_Base	.520**	**1**							21.38
Org_Crea	.817**	.437**	**1**						2.44
Entr_Cap	.161	-.213*	.205*	**1**					1.94
$Know\_Base^2$	.415**	.967**	.360**	-.218*	**1**				19.98
Know*Crea	.660**	.965**	.623**	-.081	.930**	**1**			1.83
Know*Entr	.655**	.883**	.591**	.205*	.844**	.932**	**1**		1.70
Entr*Crea	.565**	.125	.697**	.834**	.076	.312**	.512**	**1**	1.66

3.3.2 Method and models

After having reviewed the descriptive statistics we will now focus on our regression method and its according models concerning our research question. In our dataset we are dealing with a binary dependent variable (innovative firm yes/no). What we want to investigate here is the determinants of an innovative firm. Having different independent variables and a binary dependent variable makes it obvious to use the binary logistic regression method. By this method it is possible to predict which category a firm belongs to (innovative or not) given a certain set of potential determinants. This means that the relationship between variables does not have to be linear which is the case with a basic linear regression yet which is mostly violated when the outcome variable is dichotomous (Berry and Feldman, 1985). In addition, the reason for this particular binary method is that the different independent variables can consist out of different measurement scales e.g. continuous or categorical, and normality and variance are corrected for, as is beneficial for our data. The ordinal logistic regression method would be applicable as well yet we have a too small sample (120) to divide the dependent variable in several categories and still achieve a reliable outcome.

Having selected the binary logistic regression method the statistics programme gives us several different options to run the analysis. The default method is “enter” by which all of the covariates are placed into the regression model in one block, and parameters estimates are calculated for each block.

Other options are the "stepwise methods" yet these are considered to be used when conducting exploratory work and the "enter" method is assumed to be the appropriate method when testing theory (Studenmund and Cassidy, 1987). Since we are testing research questions which are deducted from our theoretical framework the "enter" method is used.

As the regression method is chosen the next step is to construct our models from which the hypotheses will be tested. The first model will test hypotheses 1, 2, 3 and 5 which are as follows:

Hyp. 1. A higher level of the knowledge base and absorptive capacity increases the likelihood for an SME to be involved in physical-end product/service innovations.

Hyp. 2. There exists an inverted U-shape between the knowledge base and absorptive capacity of an SME and its likelihood to be involved in physical-end product/service innovations.

Hyp. 3. A higher degree of organizational creativity increases the likelihood for an SME to be involved in physical-end product/service innovations.

Hyp. 5. A higher level of individual and organizational entrepreneurship increases the likelihood for an SME to be involved in physical-end product/service innovations.

The statistical expression for model 1 is:

$$Innovative\ SME = \alpha + \beta_1\ \text{Know\_Base} + \beta_2\ \text{Org\_Crea} + \beta_3\ \text{Entr\_Cap} + \beta_4\ \text{Know\_Base}^2 + \varepsilon$$

It is straightforward to include all the "separate" independent variables from the hypotheses in one model. In addition, when testing for an inverted U-shape the squared term of an independent variable should be added as well. Of course the control variables are added in all models. As we just described the interaction terms from hypotheses 4, 6 and 7 will be tested in three according separate models to enhance interpretability. These three models will entail all the separate independent variables and one interaction term consisting out of two of the three main independent variables.

The 2nd model will test hypothesis 4 which is as follows:

Hyp. 4. The interaction between the knowledge base/absorptive capacity and organizational creativity will increase the likelihood for an SME to be involved in physical-end product/service innovations.

The statistical expression for model 2 is:

$$Innovative\ SME = \alpha + \beta_1\ \text{Know\_Base} + \beta_2\ \text{Org\_crea} + \beta_3\ \text{Entr\_Cap} + \beta_4\ \text{Know\_Base} * \text{Org\_Crea} + \varepsilon$$

The 3th model will test hypothesis 6 which is as follows:

Hyp. 6. The interaction between the knowledge base and absorptive capacity of a firm with individual and organizational entrepreneurship, increases the likelihood for an SME to be involved in physical-end product/service innovations.

The statistical expression for model 3 is:

$$Innovative\ SME = \alpha + \beta_1\ \text{Know\_Base} + \beta_2\ \text{Org\_crea} + \beta_3\ \text{Entr\_Cap} + \beta_4\ \text{Know\_Base} * \text{Entr\_Cap} + \varepsilon$$

The 4th model will test hypothesis 7 which is as follows:

Hyp. 7. The interaction between organizational creativity and individual/organizational entrepreneurship increases the likelihood for an SME to be involved in physical-end product/service innovations.

The statistical expression for model 4 is:

$$Innovative\ SME = \alpha + \beta_1\ \text{Know\_Base} + \beta_2\ \text{Org\_crea} + \beta_3\ \text{Entr\_Cap} + \beta_4\ \text{Org\_Crea} * \text{Entr\_Cap} + \varepsilon$$

3.3.3 Hypotheses testing

Now the models in which the hypotheses will be tested are clear and we have discussed the preliminary results, the next step is to run a regression on the models. Table 10 shows the results of the binary logistic regression on the models 1-4. Regarding Model one testing hypotheses 1, 2, 3 and 5 one can see that three of these hypotheses are accepted on a 5% significance level. The individual variables Know_Base and Org_Crea seem to have a positive effect on the likelihood for an SME to be innovative, hypotheses 1 and 3 respectively. Furthermore, the variable Know_Base shows a positive significant sign and the variable $Know\_Base^2$ a negative significant sign indicating that there exists an inverted U-shape regarding the effect of the Know_Base on the innovativeness of an SME. The latter supports hypothesis 2. However, the variable Entr_Cap does not seem to have a significant effect on the innovativeness of a firm rejecting hypothesis 5.

Model two includes the variable Know_Base*Org_Crea which tests for hypothesis 4. The model shows a positive significant (5%) effect on the likelihood for an SME to be innovative and sustains hypothesis 4. In addition, the variables Know_Base and Org_Case show a positive significant sign as well.

Model three includes the variable Know_Base*Entr_Cap which tests for hypothesis 6. The model shows a positive significant (5%) effect on the likelihood for an SME to be innovative and sustains hypothesis 6. Again the variables Know_Base and Org_Case show a positive significant sign as well.

The last model, 4, includes the variable Entr_Cap*Org_Crea and tests for hypothesis 7. The models shows a negative sign yet not significant and therefore rejects hypothesis 7. The variables Know_Base and Org_Crea do show a positive significant sign in model 4 and are therefore quite robust throughout the models. In the next section these results will be elaborated on and backed up by literature where possible.

Table 11: Binary Logistic Regression, models 1-4, dependent variable Innovative SME, N=120

	Model 1	Model 2	Model 3	Model 4
Constant	-47.40 (14.24)**	-6.03 (3.05)**	-4.49 (3.29)	-5.65 (2.65)
Independent variables				
Know_Base	5.02 (1.86)**	.89 (.29)**	1.74 (.56)**	1.00 (.31)**
Org_Crea	8.11 (2.64)**	8.30 (2.65)**	5.01 (1.56)**	5.47 (1.32)**
Entr_Cap	.65 (1.14)	-.37 (.87)	1.38 (.99)	.95 (.64)
$Know\_Base^2$	-.44 (.17)**			
Know_Base*Org_Crea		1.59 (.80)**		
Know_Base*Entr_Cap			1.06 (.40)**	
Entr_Cap*Org_Crea				-1.81 (1.23)
Control variables				
Size	.117 (.06)**	.09 (.05)*	.05 (.05)	.06 (.04)
Age	.06 (.05)	.02 (.02)	.02 (.02)	.03 (.02)
Independence	-.21 (1.55)	1.65 (1.40)	1.30 (1.38)	1.20 (1.23)
Industry	-.164 (1.79)	.33 (1.53)	.11 (1.57)	.63 (1.45)
Advisory	-1.23 (2.04)	-.03 (1.68)	.65 (1.67)	1.16 (1.61)
IT	-1.17 (1.87)	-.87 (1.89)	-.74 (1.82)	-.16 (1.74)
Health	-1.51 (2.43)	-2.08 (2.26)	-.91 (2.31)	-.24 (1.98)
-2 Log Likelihood	**29.827**	**40.608**	**34.060**	**44.804**
Cox & Snell R-square	***.679***	***.649***	***.668***	***.637***
Nagelkerke R-square	***.906***	***.866***	***.891***	***.849***

B-Value without brackets, S.E. between brackets. $\alpha \leq 0.10$*, $\alpha \leq 0.05$*

4. Discussion

Regarding the empirical results of the regression one can see that the hypotheses 1, 2, 3, 4 and 6 hold and the hypotheses 5 and 7 are rejected. Hypotheses 1 and 2 concern the knowledge base and absorptive capacity of the firm and its contribution to an innovative output. The knowledge base of an organization is defined here as the embedded collective knowledge of individuals within the firm (Nonaka et al. 2000) used to achieve the firm's productive purposes and final output (Saviotti et al., 1998). The absorptive capacity is part of the knowledge base and is necessary to absorb external knowledge as individuals within the firm have to be able to recognize and assimilate this new knowledge (Cohen and Levinthal, 1990). Hypotheses 1 stating that a higher level of the knowledge base and absorptive capacity increases the likelihood for an SME to be innovative is supported and in line with theory. As the capital of SMEs is shifting from tangible to intangible assets we have to look further than specified R&D departments and hard capital. The knowledge base, one of our three building blocks to innovate, is made up from several determinants: in-house (informal) R&D departments, R&D spending, higher educated personal and founder, qualified scientists and engineers (QSEs) and linkages with universities, suppliers/competitors and government. All these determinants show to have a positive effect on the innovativeness of a firm. Notable is that innovative SMEs buy external knowledge and ideas as frequently as non-innovative SMEs (30%) and they tend to innovate mostly in informal manners having R&D and innovation incorporated in their daily way of doing business. Although our results are in line with most theories there are also some contradictions to be found in the determinants making up our knowledge base. Hoffman et al. (1998) point out contradicting literature concerning knowledge sources as some states that particularly high-technology sectors have strong and diverse external knowledge linkages while others find evidence that counters this positive assumptions. Furthermore, there are country specific preferences for external linkages and sources of knowledge as Japanese SMEs find links with universities most useful while US SMEs put more value on on-site linkages and training for managers (Le Blanc et al., 1997). Nevertheless, our research includes different sectors of industry and finds a positive effect of these determinants on the innovativeness of Dutch SMEs.

Hypotheses 2 states that there exists an optimal point and a trade-off is made between holding and absorbing knowledge and having an open view to a broad scope of new knowledge. Knowledge accumulation often requires different, complementary sources of knowledge by which novel sources trigger new ideas and creativity. Too much proximity could hamper this process and lead to cognitive lock-in where routines within organizations blur the view on new resources of innovation and market possibilities. The stacking nature of knowledge creation can be detrimental for the well being of an organization something defined as the "competency trap" (Levitt and March, 1996). Our results supports this theory since we found an inverted U-shape regarding the knowledge base and absorptive capacity.

The necessity to keep a broad and open view and stay creative brings us to Hypothesis 3 which states that a higher level of organizational creativity increases the likelihood for an SME to be innovative. Creativity is the process of original thinking and expression and can come in the form of a new idea; innovation on the other hand is the application of such creative idea within a particular framework. Literature argues that creativity is a multi-level phenomenon starting with the individual and resulting in organizational creativity through groups and contextual influences (Woodman et al., 1993) and in this way is vital to a firms innovative performance. Organizational creativity under this research is measured by the KEYS to creativity (Amabile et al., 1996) which includes positive and negative scales: *Encouragement of Creativity, Autonomy or Freedom, Resources, Pressures and Organizational Impediments to Creativity.* Our results are in line with theory and show that possessing a higher degree of Organizational Creativity increases the likelihood for an SME to be innovative. A notice to make is that Organizational Creativity also entails physical resources and is not confined to the regulation and stimulation of human capital and intangible assets. Resources here can also entail financial resources or the lack of them which is for example considered as a limitation for product and process innovation by 43% of the managers in US SMEs (Le Blanc et al., 1997). However, contradictory findings show that only a very small amount of SMEs looking for financial resources fail to succeed (Hoffman et al., 1998). In addition, where some suggest that there is a direct positive relationship between R&D expenditures and innovative performance (Oerlemans et al., 1998) others found no such direct relationship between direct R&D spending nor formal links with external R&D organizations and innovative performance (Birchall et al., 1996).

Our study shows in fact that SMEs spending little or nothing of their turnover on (formal) R&D are just as likely to achieve product innovations. However, R&D spending fall within our building block of the knowledge base mentioned previously to come back on that matter.

The knowledge base we discussed under hypotheses 1 and 2 has to have the ability to flow free throughout the organization without too many impediments and barriers. Despite the fact that both the knowledge base and organizational creativity show a positive effect on the innovative performance of a firm it may be insufficient for a firm to only show excellence in one of the two. Research shows that the degree and variety by which an individual is exposed to information and knowledge is of importance to that individual's creativity (Sternberg and Lubart, 1995; Amabile, 1996). On the other hand, it is the organizational environment as elaborated before which has to allow for this knowledge to be appropriated. Creativity is the starting point of innovation by generating new ideas (Amabile et al., 1996) yet may be insufficient to innovate because of the lack of relevant knowledge and information which could lead to re-inventing the wheel over and over again (Koellinger, 2008). Moreover, it may be the combination of knowledge and creativity (Gurteen, 1998) or organizational learning and creativity (Huber, 1998) which leads to innovation. Hypothesis 4 supports the theory that there is an interaction between the knowledge base and organizational creativity to be found which has a positive effect on the likelihood for an SME to be innovative. This result shows that there is more to innovation than separate determinants and could also explain why some determinants under different specific studies do matter while others do not.

This brings us to hypotheses 5, and our last building block, which states that a higher level of individual and organizational entrepreneurship increases the likelihood for an SME to be innovative. As stated before we unfortunately could not split hypothesis 5 in an individual and organizational part as our dataset did not include enough responses from as well the founders of the firm as the managers and employees. This means that the effect of individual and organizational entrepreneurship on the innovative performance of the firm was taken as one and this effect turned out to be insignificant and thus not supporting hypothesis 5. Among others, our theoretical framework discussed that the individual entrepreneur is different from a small business owner in the sense that the former is set more to innovative (Steward et al., 1998) and that entrepreneurship can be viewed within an organizational framework as well enhancing the innovative performance (Antonic and Hirsch, 2003).

However, the questions under this research on entrepreneurial attitudes, actions and risk within the firm did not support this. One reason for this negative outcome may lie in the apparent fact that individual and organizational entrepreneurship could not be tested for separately as both the generic and context specific circumstances may play a role. In addition, not the right questions might be used in this research to test for this. A second reason may lie in the difference between what managers say they do and the true "theories in use" within the organization (Argyris and Schön, 1996). Managers might answer that entrepreneurial, risk-taking and innovative behaviour is supported and stimulated while the opposite is true due to e.g. the fear to be outsmarted by an employee. A third reason for our result may be that the variables under concern interact with other variables bringing us to the last two hypotheses on interactions. First hypothesis 7 will be discussed defining that there is an interaction to be found between individual/organizational entrepreneurship and organizational creativity.

The starting point for this interaction on individual level is that the ability to invent and the ability to commercialize this invention in other words the capability to seize business opportunities does not have to coincide within one and the same person. However, many of the know inventors were both inventive and entrepreneurial (Khan and Sokoloff, 1993). In general lines both individual creativity and entrepreneurship can be extended to the organizational level as discussed under the theoretical part. The dimensions making up the framework of organizational creativity such as risk, freedom and challenge (Amabile, 1996; Andriopolous, 2001) overlap with the characteristics and dimensions of respectively individual and organizational entrepreneurship. In addition, creativity can be viewed as part of the process by which ideas are generated, innovation as the process by which this creativity is implemented and entrepreneurship as the individual and organizational process by which innovation takes place (Kao, 1991). However, hypothesis 7 on the interaction between individual/organizational entrepreneurship and organizational creativity is not supported. Again one reason for this might be the somewhat poor and combined measurement of individual and organizational entrepreneurship. Another reason can be found in literature which argues that in the early organic stages the entrepreneur might be the driver of creativity and invention yet when moving into the more solid processes of exploitation and commercialization the entrepreneur may not have the most suited capabilities e.g. leadership. The entrepreneur may even form an obstruction to networked solutions, or outsourcing decisions that can be essential for moving from idea to business implementation (Davidsson et al., 2001; Nilsson, 2003).

A notable difficulty under this study, which incorporates many determinants of innovation within three main building blocks, is the capability to capture the effects on organizational or firm level. Many outcomes, especially regarding entrepreneurship, are context specific from an individual and environmental point of view. This problem could be overcome as contemporary frameworks would be developed similar to Amabile's KEYS to creativity (1996) which would allow to measure for e.g. "entrepreneurial capital" on firm level.

To finish up the discussion we end with hypothesis 6 which states that there exists a positive interaction between individual/organizational entrepreneurship and the knowledge base regarding the innovative performance of the firm. Again this can be viewed from different perspectives. Acs et al. (2005) accentuate that business opportunities are the result of new knowledge created endogenously through R&D investments of firms. Because of the fact that this knowledge can not always be appropriated (Geroski, 1995) it may be also used by other firms. In addition, there is the phenomenon of independent external organizations creating new knowledge for firms to use e.g. universities and government institutions. It is said that this new knowledge generated by (informal) R&D is likely to encourage innovative entrepreneurship (Acs et al., 2005). Yet, when viewing it from an organizational point of view individual and organizational entrepreneurship could contribute the knowledge base of a firm similar to absorptive capacity as entrepreneurship involves recognizing, capturing and appropriating ideas (Johnson, 2001). While our third building block of the "entrepreneurial capital" of the firm does not show a positive effect on the innovative performance of the firm on its own nor in the interaction with organizational creativity, it does interact positively and significant with the knowledge base and therefore supports hypothesis 6.

5. Conclusion

The starting point for this study is the importance of innovation for the wealth of individuals, firms and nations. The locus of innovative activity in this thesis are SMEs which is sustained by the shift from the managed to the entrepreneurial economy with SMEs being the engine of growth. Although more and more research is focused on the innovative performance of SMEs and the means by which they do so, many questions are yet unresolved.

When reviewing literature on the determinants of innovation within SMEs often a distinction is made between internal and external factors. Recent research has combined both internal and external determinants to get an better understanding about the factors determining innovation yet there are still contradictions and grey areas within literature to be found. This is not that surprising since innovation is a complex process to address. First, there is the method of measuring innovation with the patenting behaviour of the firm being preferred for a long time. However, as there are different kind of innovations e.g. product, process and organizational innovations, the process by which these innovations are accomplished is most likely assumed to be different. This means that a more direct measurement of innovations would be preferred. In addition, as our research also shows, SMEs do not always tend to patent their innovations. Second, there is the difference in levels of innovation among industry sectors with the high tech sector being addressed mostly in studies. Demarcating the type of innovation and its measurement method together with a more general population of different industry sectors could contribute to understand this complex processes of innovation. In addition, the classical view of R&D being the driving force behind innovation should be reconsidered in the case of SMEs as they tend to innovate in informal manners with formal R&D being only slightly related to innovation.

When R&D shows to be less apparent or less intensive e.g. in the case of SMEs or low-tech industries, research becomes poor and inconclusive. The main research question we therefore addressed under this study is: *"What are the determinants of product innovations within Dutch SMEs and how do they interrelate?"*.

To overcome some of these complexities this study incorporated SMEs from different industry sectors and measured their innovative output in a direct and reliable manner.

Furthermore, what is new under this study are the interactions tested between different determinants of innovation. Activities to innovate correlate with a substantial number of variables. Some recent research has tried to incorporate most of these variables yet an important attribute is that little or no focus has been laid on the possible interactions between variables. Therefore, under this study we tested for many different variables yet first this single variables were grouped into three main building blocks of innovation deducted from our theoretical framework. This three main flanks are: Knowledge Base, Organizational Creativity and Entrepreneurship Capital. Where other research looks at e.g. the R&D intensity, educational level, risk taking behaviour and external linkages separately under one model this research first grouped this possible determinants under one of our main building blocks which make up for our new variables. In this manner it is possible to test for interactions and give more insight into the complex process of innovations within SMEs. In addition, some of the contradictions in literature about the determinants of innovation could be explained by the fact that some of these variables do interact.

This research shows that the Knowledge base and Organizational creativity of the firm are most important in attaining an innovative output. In addition, there is an inverted U-shape between holding knowledge and being innovative meaning that there is an optimal amount to be found. When current processes are not challenged nor are the individuals within the organization a chance of cognitive lock-in is not unthinkable. The collective knowledge held by individuals within the firm and the absorptive capacity of the firm is the basis of innovation. The knowledge base does not only include formal R&D spending and activities yet also what we call informal R&D e.g. external linkages with universities or government and the sharing of external R&D departments with other firms. Furthermore, the knowledge base includes the educational level of the employer and employees and the amount of qualified scientists and engineers within the organization. This study shows that SMEs do not tend to generate and use knowledge in classical manners yet they innovate in informal ways having R&D activities spread throughout the organization. An additional insight is that they do not even always patent their innovations yet are still able to commercialize their ideas. It would be useful to develop a framework by which this informal activities could be measured appropriately for comparison. The latter also because the knowledge base and absorptive capacity of SMEs are mostly intangible and developed as by products of a firms activities. According to theory it is organizational creativity which facilitates this process in the context of innovation.

Organizational creativity is measured by the KEYS to creativity, an established and tested framework, consisting out of 6 positive and 2 negative scales. *Encouragement of Creativity, Autonomy or Freedom, Resources, Pressures and Organizational Impediments to Creativity.*

The organizational creativity of a firm does not only entail intangible yet also tangible determinants e.g. the (financial) resources available to complete ones tasks. Organizational creativity shows to have a positive contribution to a firms innovative output. In addition, the knowledge base and organizational creativity do interact positively with respect to innovation which is an important outcome concerning the single determinants making up this variables.

Entrepreneurship capital here are the attitude, actions and risk taking behaviour of the firm concerning entrepreneurship. The results do not show a positive contribution to innovation when looking at the one on one relationship. Yet, when looking at the interactions with organizational creativity and the knowledge base a positive effect is found with the knowledge base. This again shows the importance of interactions as the variable is not able to make a contribution to innovation on its own yet does so when there is an appropriate knowledge base and absorptive capacity within the firm. This could mean that an entrepreneurial spirit of the organization is necessary to commercialize ideas yet knowledge about the market and the ability to appropriate information is vital as well. An additional insight found in our results is that intrapreneuship is possible among SMEs something only considered possible within larger firms. An SME is mostly build around an innovative product yet when the founder comes up with a new product different from the current industry he or she will most likely start up a new SME. Furthermore, we also argued that entrepreneurship should not only be viewed at individual or industry/country level yet also on organizational level. A notice to make is that we possibly could not measure organizational entrepreneurship adequately and again it would be useful to have a framework developed for measurement purposes.

Altogether, this work used a reliable method of measuring innovation, demarcating product innovations and including different industry sectors. In addition, many determinants were used grouped into three main variables which were tested on their mutual interactions. The results show not only some interesting outcomes contributing to the complex process of innovation yet also give some direction for further research.

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