ABSTRACT

A key issue in the innovation process is how firms balance their exploration and exploitation activities. Various studies on large firms have suggested that relying too heavily on exploitation reduces performance. Little is known about the trade-off between exploration and exploitation in firms of smaller size. Consequently, the dissertation aims to investigate this trade-off and its effect on innovative performance in medium, small, and micro firms. It will also examine whether a bias towards exploitative activity has the effect of displacing radical innovations with incremental innovations. Until the exploration–exploitation trade-off and its effects are analysed in these firms, an important aspect of innovation will remain a puzzle. In this dissertation, exploration and exploitation will be investigated through the analysis of knowledge recombination, economic factors (such as R&D investment) and social factors (such as a firm’s openness and collaboration); the data will come from innovation surveys and patent statistics.
TABLE OF CONTENTS

INTRODUCTION ................................................................................................................................. 2

LITERATURE REVIEW: Theory and Empirical Evidence ................................................................. 3

RESEARCH QUESTION ....................................................................................................................... 4

RESEARCH DESIGN: Methodology and Data .................................................................................... 5

1. Theoretical Approaches to Exploration and Exploitation ......................................................... 5

2. Exploration, Exploitation and the Recombination of Knowledge ............................................. 6

   2.1. Patent Data: EPO and USPTO ............................................................................................ 7

   2.2. Variables ............................................................................................................................. 7

   2.3. Method of Estimation .......................................................................................................... 8

3. Exploration, Exploitation and Economic and Social Factors ............................................... 8

   3.1. Community Innovation Survey Data (CIS) .......................................................................... 9

   3.2. Descriptive Statistics .......................................................................................................... 9

   3.3. The Econometric Model ...................................................................................................... 10

   3.4. Variables ............................................................................................................................. 10

   3.5. Method of Estimation .......................................................................................................... 11

   3.6. Innovation in Micro Enterprises: An Illustration .............................................................. 11

4. The Exploration-Exploitation Balance Inside the Firm: A Case Study on Medium, Small and Micro firms .................................................................................................................. 12

THE FINAL PART OF THE DISSERTATION .................................................................................... 14

REFERENCES ....................................................................................................................................... 15
INTRODUCTION

In 1903, it did not occur to anyone that rain or snow on a moving vehicle's windshield was a problem that could be resolved. It was something drivers simply had to accept and deal with in various ways. A young woman named Mary Anderson changed all that as she noticed that drivers in New York kept stopping their cars and getting out to remove snow and ice from their windshields. She was troubled by this and made a drawing of a mechanical device she thought could do this job. Anderson was granted the patent for the windshield wiper in 1903, but she was told that it was of little commercial value. Today her invention represents a true innovation and is found on almost every vehicle around the world (Alabama Journal, 1972).

This story illustrates the importance of innovations and their particular character. It shows that innovation is something that starts when people are disturbed and motivated to introduce change. It can be found around the corner and across the globe. Innovation needs more than conventional logic and emerges when there is disruption, creativity, and imagination.

In order to succeed in today’s competitive marketplace and to have sustainable growth, companies need to undertake a variety of innovation efforts. First, they should constantly pursue incremental innovations, small improvements in their existing products and services that help them operate more efficiently. Then, businesses need to introduce radical innovations to improve their competitive position, often replacing old products or making them obsolete. This can be done for instance by creating new market spaces (also known as blue oceans) with new business models that make competition irrelevant (Kim and Mauborgne, 2005).

It is important to study what firms do and how they solve problems by innovating (Nelson and Winter, 1982). Innovations lie at the heart of entrepreneurial activity and wealth creation and are an important part of the process of creative destruction, since they “incessantly revolutionise the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of creative destruction is the essential fact about capitalism” (Schumpeter, 1942:83).

A growing literature in economics, organization theory, and management explores the sources of innovation, radical and incremental. According to the seminal article by James March, a key source of innovation is how firms balance their exploration and exploitation activities. March (1991:71) defines exploration activities as including “things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation.” In contrast, exploitation activities include “such things as refinement, choice, production, efficiency, selection, implementation, execution”. In general, exploration activities are associated with radical innovations and exploitation activities with incremental innovations. Due to resource constraints firms must decide whether and at what extent to pursue each activity. This dissertation aims to investigate the consequences of this trade-off.
LITERATURE REVIEW: Theory and Empirical Evidence

The argument put forward by March (1991) that firms need to balance their exploration and exploitation activities to improve growth performance is widely accepted in the literature (Benner and Tushman, 2002, 2003; Gupta et al., 2006). In other words, firms need to perform well at both tasks to achieve sustainable growth. Exploitation can be considered as an activity of routinised search, which incrementally increases the existing knowledge and competencies of firms. Exploration, on the other hand, can be characterised as a search process for opportunities in fields that are new to the firm (Levinthal and March, 1993).

Recent research has applied different approaches to study the exploration–exploitation balance. Some studies have used panel data research design (Uotila et al., 2009; Vanhaverbeke et al., 2005; Katila and Ahuja, 2002) and other studies have applied a cross-section or pooled cross-section analysis (Jansen et al., 2006; He and Wong, 2004). Moreover, they use different operationalizations of the balance between exploration and exploitation. For instance, there are studies that use as proxies patent data (Katila and Ahuja, 2002) or content analysis of news about a company (Uotila et al., 2009). The results of these studies imply that large companies that tend to systematically over-emphasize exploitation may reduce their long-term performance.

Lupatkin et al. (2006) explore the exploration and exploitation trade-off by investigating the role of top management team behavioural integration (such as information exchange and joint decision making) in small and medium firms. They find that the role of top managers is important for the exploration–exploitation balance. They define small and medium firms as firms employing from 20 to 500 individuals.

Two previous studies are particularly important for the approach in this dissertation. First, Mairesse et al. (2006) examine a new framework for measuring innovation (what they call “innovativity”), using firm data for seven countries from the European Community Innovation Surveys (CIS). They apply a framework similar to the one used in production analysis and provide a measure of “innovativity” comparable to that of total factor productivity. Second, Laursen and Salter (2006) explore the openness of firms’ external search strategies and their innovative performance. They find that firms that search more openly tend to have better innovative performance. Their study is an empirical investigation of Henry Chesbrough’s (2003) work about the “open innovation model”. According to this model, firms that rely heavily on internal knowledge may miss early signals of new market opportunities. Moreover, in order to take advantage of these opportunities they may require external knowledge (Chesbrough, 2003).¹

The literature shows that innovation entails an important trade-off between exploration and exploitation. But the literature focuses primarily on how this happens in large firms. This dissertation aims to investigate the exploration–exploitation trade-off in small and medium firms and to assess the extent to which this trade-off functions the same way across all firm size classes. This is a critically important question in countries such as Italy, where small and medium firms are the most common form of business organization and generate the majority part of jobs.

¹ A famous example for opening up the innovation process and implementing an open innovation model is the Connect + Development program at Procter and Gamble (Huston and Sakkab, 2006).
RESEARCH QUESTION

The overall objective of this dissertation is to model, analyze, and measure the balance between exploration and exploitation in small and medium firms. The research question proposed is: How does the balance—or mix—between explorative and exploitative activity affect innovativeness and performance in these firms? Previous studies have mainly considered exploration and exploitation in large enterprises (e.g., Ahuja and Lambert, 2001; Jansen et al., 2006; Uotila et al., 2009) or have applied a different focus on exploration and exploitation activity (Lupatkin et al., 2006). Moreover, it seems that there are no published studies on exploration, exploitation, and innovation that directly analyse micro firms that employ less than ten individuals. Generally, these firms are overlooked because data about them are not readily available. However, medium, small, and micro firms play an important role, since they provide employment for the majority of the population and in many sectors they are responsible for driving innovation and competition (Acs and Audretsch, 1988, 1990; Audretsch, Santarelli, and Vivarelli, 1999; Cohen and Klepper, 1996).

The dissertation will address this gap and analyse the exploration–exploitation balance and its influence on innovative performance by investigating medium, small, and micro firms (i.e., employing 1 to 250 individuals). It will examine whether a bias towards exploitative activity has the effect to displace radical innovations with incremental innovations. The exploration–exploitation balance will be measured by considering economic factors (such as R&D investment) and social factors (such as collaboration). By looking at different forms of collaboration activity it will be possible to find out whether innovative firms apply an open innovation approach.

The analysis will be both theoretical and empirical. The theoretical part will compare different theories that have tried to explain the connection between exploration–exploitation activity and performance. The conceptual distinction between exploration and exploitation will be investigated from various perspectives: new endogenous growth theory (Romer, 1990), evolutionary economics (Nelson and Winter, 1982), and organization theory (March, 1991). Based on the theoretical analysis, a framework and several hypotheses will be developed about how exploration and exploitation activities relate to innovativeness and performance.

The empirical analysis will consist of two parts. The first part will analyse the nature of recombination of new with existing knowledge and will be based on patent data for medium, small, and micro firms. The second part will investigate the forms of collaboration and the type of investment. It will be carried out on data for medium, small, and micro enterprises in Italy, Germany, and Switzerland. Based on the Community Innovation Survey (CIS), panel data will be extracted and analysed to control for individual firm fixed effects and to investigate the dynamics of innovation. This analysis at the national level will be complemented by a more detailed illustration of innovation in micro firms. This illustration will be located in the South Tyrol (Alto Adige) region in northeast Italy.² There is one major reason for this choice. Standard innovation surveys, such as those carried out by the national statistical offices all over

² The South Tyrol region, is a province of Italy and is also known as Autonomous Province of Bolzano. It is part of the Trentino–South Tyrol region (in Italian Trentino-Alto Adige). In what follows the term region of South Tyrol will be used (similar to Perkmann, 2006).
Europe, usually do not consider micro firms or firms with less than five employees. However, increasingly innovation policy focuses on firms of all sizes. Strengthening the capabilities of firms and their innovation potential has become relevant at every level, from the smallest to the largest firms. Fostering a so-called “innovation culture” has become an important objective for policymakers at regional, national, and European levels.

**RESEARCH DESIGN: Methodology and Data**

This dissertation will employ firm level data of medium, small, and micro enterprises to examine how exploration and exploitation activity relate to innovative performance. March (1991) proposes a framework and description for the terms exploration and exploitation. His argument focuses on the relationship between the exploration–exploitation balance and performance. The effect of the exploration–exploitation balance on innovative performance of a firm will be analyzed with respect to such characteristics as the ability to produce radical innovations—the introduction of products new to the world market—and incremental innovations—products new to the firm or considerably improved. The balance between exploration or exploitation activity varies for several reasons. In this dissertation among the factors that will be examined are economic factors (such as R&D investment) and social factors (such as a firm’s openness and collaboration).

The dissertation will consist of four interconnected sections. The first will discuss innovation from a theoretical point of view by examining its treatment in several theories and by developing an appropriate framework. The second and third will analyze the exploration–exploitation trade-off and its effect on innovative performance in medium, small and micro enterprises. Moreover, this section will include a more detailed illustration of micro firms in the craft sector. The craft sector is characterized by its particularly small firm structure, with the majority of firms having less than five employees. Firms with such a small size, such as the hairdresser or the baker, are classified as micro firms. To further extent knowledge about the exploitation and exploration trade-off, the dissertation will include single case studies in the fourth section. Firms will be contacted and interviewed to get more qualitative insights on the trade-off and the innovation process.

**1. Theoretical Approaches to Exploration and Exploitation**

In this section the purpose is to review existing theories and models on exploration and exploitation activity, and to propose a framework so that understanding of it can be improved. At the beginning the contributions of several theories on innovation and growth will be presented. Then, a framework to explain the exploration and exploitation trade-off will be proposed. This framework will follow the evolutionary approach pioneered by Nelson and Winter (1982). The reason for this choice is that this approach has made important progress towards the combination of Schumpeter's idea of innovation as implying creative destruction and Simon's idea of bounded rationality and procedural rules that underlie economic behaviour (Simon, 1955). In
this way the evolutionary approach has proved to be a major contributor to endogenous economic growth, innovation studies, and technology-based industrial dynamics (Castellacci, 2007).

The reference model for studying the exploration-exploitation trade-off will be the model by Fagiolo and Dosi (2003). The rationale for extending this theoretical model is that it has little focus on the microeconomic level and does not directly treat competition. Moreover, theoretical treatments of exploration and exploitation are rare and the proposed framework is expected to contribute to the knowledge of the dynamics and effects of the exploration-exploitation trade-off on innovation and growth.

Particular attention will be paid to learning and the development of competences, but also to path dependencies, and competition. These concepts are important elements of the theories that try to describe the innovation process. First, learning and new knowledge generation is an activity connected to the concept of organizational “routines” (Nelson and Winter, 1982). Routines are patterns of interactions which represent successful solutions to particular problems and which are resident in the behaviour of individuals. For instance, R&D activity proceeds through the use of routines to learn where to investigate, how to investigate and how much to investigate. Second, path dependency refers to the idea that early competition among technologies can determine which technology ultimately prevails (Cowan, 1990; Arthur et al., 1987; Arthur, 1989). In essence path dependence means that history matters. Thus, path dependence is said to account for the continued use of a range of apparently inferior technologies. In economics the empirical standard example is the process which led to the emergence of the QWERTY keyboard (David, 1985). Third, competition refers to the idea that the market works as a selection mechanism, with more successful firms growing and less successful firms shrinking.

2. Exploration, Exploitation and the Recombination of Knowledge

Several scholars have argued that new knowledge is created by particular recombinations of existing knowledge available (see Schumpeter, 1939; Basalla, 1988). Though innovators can possibly combine any knowledge, what actually gets combined is constrained by their degree of explorative and exploitative activity. Searching into a “new to the firm” technology domain increases the number of opportunities to which the firm has access (Fleming, 2001). The new knowledge gained through this search activity in the new technological domain can then be recombined with its existing knowledge (Basalla, 1988) to introduce more variety that facilitates problem solving (Kogut and Zander, 1992). This variety in problem solving approaches increases the likelihood that solutions can be found for particular technological challenges. In addition to solving old problems, recombining knowledge from new domains can also enhance the impact of the innovation. Indeed, it has been argued that breakthrough innovations result from recombining non-obvious technology components (Basalla, 1988; Utterback, 1994). Hence, when a firm taps into a new domain, it could combine new knowledge with its existing knowledge to yield radical innovation (Ahuja and Lampert, 2001; Katila and Ahuja, 2002).
However, extensive experimentation may be counterproductive. When firms enter multiple domains, it becomes difficult to effectively absorb and process knowledge from these domains (Cohen and Levinthal, 1990). Similarly, applying new knowledge is a time-consuming and expensive endeavour (March, 1991); a luxury in resource-constrained firms of smaller scale.

The dissertation will analyze these two conflicting effects. Thus, on one hand, combining distant domains and doing exploration is expected to provide radical innovation. On the other hand, exploring distant domains will lead to high costs and undeveloped innovations. In reference to the exploration-exploitation balance the question to be investigated will then be stated in the following way: How does the innovative performance change in firms of smaller scale when we consider proximate search as exploitation and distant search as exploration?

2.1. Patent Data: EPO and USPTO

This study will make use of patent data to analyze the effect of the exploration-exploitation balance on innovative performance. Several authors have used patent data as an indicator of exploration activity (see Katila, 2002; Rosenkopf and Nerkar, 2001). Patent data for micro, small, and micro firms will be drawn from the EPO (European Patent Office) and the USPTO (United States Patent and Trademark Office). Patent year, patent class, assignee names, number of sub-classes, and a number of other characteristics will be used to construct the patent dataset.

Patents have been mainly used to identify outcomes of R&D activities, but they have been also used to capture the technological capabilities or portfolios of firms. For example, Jaffe (1986) used patents to characterize the technological position of firms. The use of patents to capture capabilities is mainly due to the availability of data. Moreover, studies have confirmed empirical links between patents and other measures of firm capabilities. For instance, Patel and Pavitt (1997) find high correlations between the firm’s primary business and the technological niches in which it patents. In addition patents are also a good proxy for R&D expenditure (Trajtenberg, 1990).

There are also some limitations in the use of patent data. First not all inventions are patented since firms may decide to protect their innovations by alternative means such as secrecy. This problem manifests itself most clearly in the sectoral variability in the propensity to patent (e.g., Cockburn and Griliches, 1987). Second, patents, by definition, will only capture codified knowledge that is embodied in new products or processes, leaving aside tacit aspects of knowledge.

2.2. Variables

Radical Innovation: The study’s main dependent variable will be a variable representing the number of high impact innovations. For high impact innovations, the proposed proxy is the number of patents that received a very high amount of citations.

Recombination new technological niche: The main independent variable will be a measure reflecting the exploration of a firm in new technological domains. This variable will be measured by focusing on two characteristics: number of entries by a
firm into “new to the firm” niches consistent with Ahuja and Lampert (2001), and distance of the firm’s existing knowledge from the new technology niche. Regarding the second characteristic, it is proposed that more distant niches will be classified as exploration activity and nearer niches will be classified as exploitation activity.

Other independent variables: among these there will be a variable about the breadth of technological capabilities. For this variable, information on the technological classes (IPC International Patent Classification) will be extracted, which will then be used to construct a measure of coherence similar to the one developed by Teece et al. (1994). By applying these measurements for an empirical analysis, more evidence on explorative and exploitative activities and their effects on innovative performance will be gained.

2.3. Method of Estimation

The main dependent variable is of a count data type, that is, it can assume only positive integer values. Given this particularity, together with the fact that panel data will be used, count-panel-data models will be chosen. In particular, Hausman et al. (1984) and Wooldridge (2005) specification will be applied. While the first is usually advocated as the seminal contribution in this stream of empirical studies, the second is a appropriate procedure that allows to take into account dynamics without having to rely on GMM estimation of the parameters of interest.

3. Exploration, Exploitation and Economic and Social Factors

In this part, the dissertation will further investigate how the balance of exploration–exploitation activity affects the innovative performance of firms. The focus will be on the investments in innovative activity, such as R&D investment, and on the forms of collaboration.

After having identified exploration and exploitation activity for each firm, the next task will be to test the hypotheses about how the trade-off between exploration and exploitation activities relates to innovativeness and performance. The estimation procedure will be carried out in two stages. In the first stage, the effect on innovativeness, measured as the ability of the firm to produce radical innovations and incremental innovations, will be estimated. In the second stage, the effect on firm performance measured as growth in sales will be investigated.

The data used in this analysis is based on the Community Innovation Survey (CIS), a survey carried out in EU countries. This company survey attempts to measure innovations directly by asking firms about their product and process innovations and their innovation inputs by asking about expenditure on R&D and other knowledge investments and the relative importance of various knowledge flows. Most studies are based on cross-sectional data from a single innovation survey. Partly because of difficulties of comparability between the single innovation surveys, panel data studies could not be made. The dissertation will address this gap and use the available data to create panel data and exploit this data to study the dynamics of innovation.
3.1. Community Innovation Survey Data (CIS)

Many studies have made use of CIS data to test hypotheses on innovation at the national level. These include Mairesse and Mohnen (2002) and Mairesse et al. (2006). In the CIS surveys of innovation, firms provide information about the inputs, such as R&D activity, the outputs, such as new products, and the behavioural dimensions which include the forms of cooperation. Through extensive piloting and pre-testing before implementation within different European countries and across different industrial sectors, the researchers have ensured that the collected data is interpretable, reliable, and valid (Laursen and Salter, 2006).

The CIS survey is similar to previous innovation surveys (Mairesse et al., 2006). Among the best known of these are those conducted by the Science and Policy Research Unit (SPRU) of the University of Sussex (Geroski, Van Reenen, and Walters, 1997), the Yale survey on appropriability (Cockburn and Griliches, 1988), and the Carnegie-Mellon survey (Cohen, Nelson, and Walsh, 2000).

Traditionally, innovative output has been measured with patent data. However, CIS data provide a useful complement to patent-based measures, because CIS surveys measure innovation results more directly and focus on innovation activities and expenditures. In addition, there is useful information on the importance of the innovation, such as whether the developed product is new to the world (radical innovations).

Up to now there exist five waves of CIS (CIS 1 for 1990-1992, CIS 2 for 1994-1996, CIS 3 for 1998-2000 and CIS 4 for 2002-2004). A few countries conduct their surveys more frequently than every 4 years (Germany has a yearly survey, Switzerland every three years, and the Netherlands have a biannual survey). The innovation surveys serve basically two purposes. First and foremost, they are used by policy makers to monitor innovation and benchmark innovation performance. Their second utility is to provide statistical data to researchers in the economics of technological change in order to determine the reasons for innovating and the effects of innovation on economic performance.

The empirical analysis will use mainly data from Italy. However, also data from Germany and Switzerland will be investigated. The reason for including other countries than Italy is to allow for comparisons among countries. Moreover, Germany and Switzerland have been selected, because they have more frequent surveys and consequently potentially more cross-section data available for constructing the panel data. The critical issue for constructing the panel in Italy will be to identify the firms, because usually, due to confidentiality issues, micro data is provided only in anonymous form. For Germany and Switzerland micro data are anonymised in such a form that constructing the panel is possible. For Italy this issue has to be checked.

3.2. Descriptive Statistics

Initially the analysis will investigate some general characteristics of innovation by applying descriptive statistics to the data set. General information such as average innovation in different firm size classes and percentages of activities carried out by
sourcing outside knowledge (collaboration) will be examined. The aim of this descriptive part is to utilize numerical and graphical methods to summarize the information revealed and look for patterns.

3.3. The Econometric Model

The econometric estimation procedure will be carried out in two steps. In the first step, the effect on innovativeness, measured as the ability of the firm to produce radical innovations and incremental innovations, will be estimated. In the second step, the effect on firm performance measured as growth in sales will be investigated.

This analysis will draw on model specifications proposed in previous studies (e.g., Laursen and Salter, 2006; Mairesse et al., 2006). It will test the hypotheses developed in the theoretical part. The model can be written in the following simplified form:

\[ \text{INNOPERF} = \beta_0 + \beta_1 \text{relexplor} + x\delta + u \]

and

\[ \text{salesgr} = \beta_0 + \beta_1 \text{relexplor} + x\delta + u, \]

where the notation \(x\delta\) is shorthand for several other independent variables (e.g., control variables), \(\text{INNOPERF}\) is innovative performance, \(\text{salesgr}\) measures the growth in sales, and \(\text{relexplor}\) is the relative amount of exploration versus exploitation at the firm level.

3.4. Variables

**Innovativeness and Performance:** The study’s main dependent variable will be the firm’s innovativeness. In this analysis innovative performance by a firm will be described by its ability to introduce radical and incremental innovations. For radical innovation, the proposed proxy is the share of sales related to products new to the world. For incremental innovations, the proposed proxy is the shares of sales related to new products to the firm or to products considerably improved. In addition, a further dependent variable reflecting a firm’s success in the market will be introduced. The proposed proxy for this variable is the sales growth rate.

**Exploration versus Exploitation Activity:** The main independent variable will be the relative amount of exploration versus exploitation at the firm level. This will be measured by focusing on two characteristics: form of cooperation applied and the type of investment in innovation (R&D expenditure). The form of collaboration will also provide insights about the search strategy applied, that is, whether an open innovation model is followed (Laursen and Salter, 2006).

The focus on the relative amount of exploration versus exploitation activity represents an extension to the model by Laursen and Salter (2006) and a new interpretation of the search strategies of firms. Moreover, by analyzing firm collaboration more extensively, information on the firm’s network will be retrieved and the influence of the strength of the ties can be analysed (Riccaboni and Moliterni, 2009). For instance, one concept to be tested might be Granovetter’s (1973) “strength
of weak ties”. Simply stated, the basic argument is that the close friend relationships (“strong ties”) will not supply as much diversity of knowledge as the relationship to acquaintances, distant friends, and the like (“weak ties”).

Control Variables: In this empirical study, to control for possible confounding effects, several relevant control variables will be included. The choice of control variables will be based on what previous studies have shown; for instance, firm age might play an important role. Older firms may have increased experience that enhances innovation; however, they may also encounter problems in keeping pace with new external opportunities (Sørensen and Stuart, 2000).

3.5. Method of Estimation

Generally, CIS questionnaires are designed in a way to give rise to censoring (Mairesse et al., 2006), which means that the variable is roughly continuous over strictly positive values but zero for a nontrivial fraction of the population. In this study, the variable is censored at two points, since the dependent variable used to measure innovativeness is the percentage of innovative sales and therefore by definition between 0 and 100. Indeed, there is a substantial number of firms with no innovative sales. Conventional regression methods fail to account for the difference between limit observations (e.g., zero) and nonlimit observations (roughly continuous between 0 and 100). Accordingly, the Tobit model will be applied, which is explicitly designed to model censored dependent variables (Cameron and Trivedi, 2005; Wooldridge, 2002, 2004; Greene, 2003).

In order to control for time-constant unobserved features of firms which might be correlated with the independent variables in the model, panel data methods such as fixed effect estimation will be applied. Moreover, the use of a lagged dependent variable in the model will be investigated, and in this case the model will be transformed into a dynamic panel model. With a lagged dependent variable the estimation procedure will change, since fixed effects estimation will lead to inconsistent results (Cameron and Trivedi, 2005). In order to avoid this inconsistency, with three periods available instrumental variable estimation will be proposed (Anderson and Hsiao, 1981). With more than three periods available GMM estimation (Generalized Method of Moments) will be proposed (Cameron and Trivedi, 2005).

3.6. Innovation in Micro Enterprises: An Illustration

In this part there will be an illustration of how exploration, exploitation and innovation takes place in small and micro firms, by looking also at firms with less than five employees. The aim of this part is to gain a better understanding of the innovation process in firms that are generally ignored in innovation surveys.

The investigation will be carried out by focusing on the craft sector in South Tyrol. Approximately 13,000 small-scale firms work in this sector, with on average three employees per firm (WIFO, 2008). The majority of craft enterprises include brick layers, carpenters, plumbers, fitters, electricians, butchers, and bakers. Characteristic for South Tyrol are the high-valued art handicrafts, including wood carving and
sculpturing. Due to their small scale, firms are rather flexible and near to the customer. On the other hand, craft firms are not very export-oriented, which makes them vulnerable to outside competition and hinders them to size new opportunities (Province of Bolzano, 2003).

In order to conduct this illustration, data from both primary and secondary sources will be used. General information about the enterprises in the craft sector will be gathered from the Chamber of Commerce of Bolzano and the regional statistical office ASTAT. The research will utilize primary data from the innovation survey carried out by the enterprise association for the craft sector in South Tyrol (LVH-APA) in collaboration with the Department for Innovation, Research, and Development. The survey was carried out during the year 2006 and investigates the innovation process inside the firms of the craft sector. It is six pages long and covers the year 2005. The sample of firms was created in order to be representative of the underlying population of craft firms in South Tyrol.

This survey is similar to the CIS survey discussed above, however it deviates in some respects. For instance, data about the specific craft sector in which the firm is operating (e.g., health care, wood, food). In addition, innovative performance is measured in a different way. Instead of share of sales, the survey collects self-reported data on: product innovation, process innovation, organizational innovation, market innovation; these were not mutually exclusive, which means that a firm could have for instance product and process innovation. Firms were also asked whether the innovation is new for the market or new for the firm. Moreover, unlike the national surveys, the data for the innovation questionnaire in South Tyrol was collected through personal interviews, which is more resource intensive but guarantees a superior quality of data.

The analysis will be carried out similarly to the empirical analysis in the second part of the dissertation. Initially there will be a section on descriptive statistics in order to summarize the information revealed and look for patterns. The next task will be to empirically assess and to study the balance of exploration and exploitation and its effect on innovative performance in this economic sector. Since the dependent variable measuring innovative performance is of a different form in this data set, the method of estimation will change. The dependent variable will be modelled as a discrete response variable. Accordingly, logit or probit regression will be applied to estimate the probability that a firm will engage in innovation (Cameron and Trivedi, 2005; Wooldridge, 2002). An example of a question to investigate with this method might be the following: Does carrying out more explorative activity increase the likelihood of a firm engaging in innovation?

4. The Exploration-Exploitation Balance Inside the Firm: A Case Study on Medium, Small and Micro firms

Moving the focus from the sector to the firm, this section will explore in more detail how medium, small and micro firms organise their innovative activities. The

---

3 LVH is the German acronym for “Landesverband der Handwerker”, in Italian “Associazione Provinciale degli Artigiani” (APA); the Department of Innovation, Research, and Development is a department of the regional government administration of South Tyrol.
managerial challenge that firms face is to find an equilibrium or optimal mix between explorative and exploitative activities. They need to search for new alternatives, but at the same time they also have to produce their products and services and meet their customer current needs.

The specific aim of this section is to analyse whether and how medium, small, and micro firms have achieved a balance between explorative and exploitative activity and what were the effects of this balance on the innovative performance. In particular the interest will be on how these firms achieve improvements in their competence and how they generate new knowledge. Knowledge typically resides in individuals and it flows within firms and between firms, which means that it takes place in social communities and networks. In such a context local embeddedness and spillover effects might play a role to enhance innovative performance. Applying a particular focus on the individuals will be important and useful when studying firms of smaller scale, since major decisions about strategy and operation are usually taken by a single person or a small team. That is, in many cases the fate of these firms is closely bound to the competences of the entrepreneur or the entrepreneurial team.

The exploratory nature of the questions addressed in this section makes a case study approach based on data collection an appropriate research strategy and a complementary analysis to the quantitative approach applied in other sections of the dissertation. It is proposed to collect data through face-to-face interviews with entrepreneurs or managers at several medium, small and micro firms. The number and geographical location of the firms to be interviewed will be decided at a later stage, and will depend on the resources available. All interviews will be taped and transcribed and then passages of the text will be grouped according to the following proposed structure:

**Organization structure**
- Internal structure of the organization (departments)
- Geographical distribution of the activities

**Process for setting objectives (aspiration levels)**
- Mechanisms in place to set objectives and deal with risks and failure

**The exploration-exploitation trade-off involved in investment decisions**
- The intensity of exploration activity and exploitation activity within the firm
- Rationale behind the use of exploration activity
- How the exploration-exploitation trade-off changed over time

**Reasons and determinants for investing more in exploration (or exploitation)**
- Knowledge accumulation vs knowledge utilization (competence)

**Knowledge exchange and accumulation**
- Nature of the knowledge being accumulated: technical vs organizational vs “social”
- Learning and positive feedback patterns
- Sources of knowledge: internal vs external (open innovation)
- The ability to absorb new knowledge generated by others (absorptive capacity)
To evaluate the data gathered with this method, the similarities and differences among the firms will be pointed out. The case study analysis will conclude with the presentation and interpretation of the results obtained.

THE FINAL PART OF THE DISSERTATION

The final part of the dissertation will compile and synthesize the findings. The results of the theoretical part and of the two empirical studies will be compared and discussed. The contributions of the dissertation to current research in fields such as entrepreneurship, organizational capabilities, and innovation will be emphasized.
REFERENCES


