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Diffusion of Technology in Developing Countries
Micro Evidence on Absorptive Capacity in Thailand

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2008
Word count: 16.025
Abstract

The thesis analyzes firm level absorptive capacity in a developing country, Thailand. The theoretical framework applied draws upon evolutionary economics, and more particularly the concepts of technological capability and absorptive capacity. Quantitative material is provided by the World Bank Enterprise Surveys. The project uses the method of factor analysis to explore variables related to the concept of absorptive capacity in the scholarly literature, in order to identify the empirical evidence of the concept. The resulting outcome clearly demonstrates several separate, while interconnected, aspects of absorptive capacity in the case of Thailand.

**Keywords:** Absorptive Capacity, Evolutionary Economics, Technological Development, Thailand, Factor Analysis.
Acknowledgements

First of all, I would like to thank Martin Srholec for his genuine support in supervising this project. I am grateful for his contributions in formulating the initial idea and for providing his academic assistance throughout these months of thesis writing. Furthermore, I want to state my appreciation of the Center for Technology, Innovation and Culture at the University of Oslo, which provided a stimulating academic program, and a friendly environment, for my MA studies. Last, but not least, I would like to thank Ingrid for her support and assistance, and my family and friends, especially my good friend and brother Johan, for their support. All mistakes that may remain are my full responsibility.

Kåre Anda Aronsen

October 2008
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1. Introduction

The thesis focuses on absorptive capacity at the firm level, with reference to foreign direct investments and its implications for technological and economic development in Thailand. The introductory chapter starts with the context of how absorptive capacity relates to foreign direct investment and economic growth, in order to highlight the impact and importance of absorptive capacity. Next, this introduction outlines the aim and structure of the thesis.

1.1 Context

“In industrialized economies, many studies have shown that more than 50 percent of long term economic growth stems from technological changes which improve productivity or lead to new products, processes, or industries” (Kim, 1980, p. 255). On this basis, one can ask how science and technology can contribute to economic development in the less developed parts of the world. The importance of technological change as a contribution to economic growth is not straightforward and clear. Different theoretical approaches differ in their basic worldview. In general, the neoclassical view is dominated by steady state solutions. The evolutionary perspective draws on historical circumstances, complexity and continuous change and turbulent growth patterns that stand in great contrast to any steady state solution. The evolutionary and neoclassical traditions have over time converged to some extent regarding the importance of technological change. But still, even the development in new growth models differs widely from the evolutionary theory on the view of the interaction between economic growth and technology (Verspagen, 2005, p. 504). The new growth models still have a worldview in which there exists a “degree” of uncertainty. Within these models, the growth process can be altered quite easily by policy. By contrast, according to
the evolutionary perspective, the process of growth varies over time and is more complex.
Within this regime it is hard to predict any outcomes of policy, due to the complex range of
interrelated factors (Verspagen, 2005, pp. 501-505).

From an economic stand, cross border investments may be the most important
manifestation of globalization (Görg and Greenway, 2004, p.171). Globalization is not a new
phenomenon, as international trade, for instance, is roughly at the same level now as it was
100 years ago. The new element of globalization is the growth in foreign direct investments
(FDI) and multinational corporations. Companies have become multinational rather than
national (Narula, 2003, p. 1). Between 1990 and 2005 the share of FDI inflows in world
gDP rose from 1 to 3 percent (Gachino, 2007, p.5). FDI has become one of the most
dynamic flows of resources to developing countries. It consists of more than financial assets,
as the package includes technology, entrepreneurship and market information (Shachwald
and Perrin, 2002, p. 3).

Theory proposes four mechanisms for spillovers from a multinational to the local
firms in the same industry in the host country. These are imitation, skill acquisition,
competition and exports (Görg and Greenway, 2004, p 173). When a foreign firm settles
down in a new country, it has expectations of a higher rate of return than local firms with the
equivalent investment. Such expectations are feasible, due to technological advantages
compared to local industry. It is obvious that foreign firms do not deliberately give local
firms direct access to their technological advantages, so if there are possible spillovers, these
are in some form of indirect technology transfer (p.173). Transfer of technology from
multinational enterprises (MNEs) includes not only the transfer of technological knowledge
to produce the products, but in addition the ability to master conceptually, develop and later
produce autonomously the technology lying behind the products (Chesnais, 2002, p.273).
Due to these expected advantages that come with spillovers from multinationals, governments in developing countries offer significant inducements to attract foreign investments. However, the existence of foreign investments does not guarantee any positive spillover effects to the local established industry.

There is extensive empirical literature on the evidence of spillovers from FDI. These are mostly econometric works that regress total factor productivity or labor productivity of the domestic firms on a range of independent variables. To measure productivity spillovers from multinationals, a variable on foreign penetration is included (usually share of employment or sales in a sector). If the result of the regression analysis is positive, it is taken as evidence on spillovers from multinational to domestic firms (Görg and Greenway, 2004, p176). These empirical estimates of spillovers for example study total factor productivity as a linear function of foreign presence (Gachino, 2007, p.10). The results of the empirical studies of spillovers are mixed.

Especially in a technically less developed country the occurrence of spillovers from multinationals’ presence is not given. The negative effect on the local industry is caused by the fact that the firm specific advantages that enable spillover are also a threat to the domestic firms. As the foreign firms have an advantage, by possessing a higher technological level, it has lower marginal costs, which can lead to the local industry being ousted by the foreign firms. The concepts can be linked to literature on technological gap. Kokko stresses that the technological gap between multinationals and domestic firms must not be too big in order for the domestic firms to have a possibility to absorb knowledge and technology from the multinationals (Görg and Greenway, 2004, p. 180).

1 See Görg and Greenway (2004) for an overview of the empirical evidence of spillovers from FDI
The review of empirical research on spillovers from multinationals shows that the research differs both in methodology and in results (Gachino, 2007, p.10). In addition, the theoretical perspectives used in the study of the phenomenon are in many cases based on traditional linear argument, which is insufficient when considering the dynamic and complex nature of spillover occurrence. It is important to distinguish technological spillovers that are non-pecuniary with pecuniary, which is easier to deduce from aggregated macro data. Spillovers include knowledge which is invisible, imperfectly understood, determined by many factors and difficult to track, hence difficult to measure and investigate (p.11).

To study the processes of spillovers, the evolutionary perspective is useful. There has been a vast development in the evolutionary literature, and literature on endogenous technological change (p.11). The key feature of the evolutionary perspective, which makes it a proper theory to use when exploring these concepts, is its view of the actors and their interaction.

In this thesis, the focus is on firms. Firms are not a group of isolated homogenous, static and isolated economic agents, but are heterogeneous members of continuous changing economic and social institutional networks. The concept of system of innovation fits the purpose of analyzing technological change, learning and innovation in developing countries. This is due to the emphasis put on learning processes. It also stresses that technological change and learning not have to stem from research and development, as firms in developing countries do not conduct much R&D (p.16).

More discriminative research is needed on the subject of spillovers from multinationals to local firms, research on absorptive capacity of domestic firms is one such aspect. When going from the view of spillovers as productivity gains, to learning and capability building, the field opens for other theoretical perspectives. In fact, firm
productivity largely depends on the firms’ accumulated knowledge and technological capabilities which are built over time (Gachino, 2007 p.16). Even though there is a relatively large empirical literature on spillovers from multinationals, there is relatively little research on the factors that really matter, among these the firm level absorptive capacity.

The effect of foreign presence is determined by many factors on several levels of analysis. One important factor for the successful occurrence of spillovers is the firm level ability to exploit new knowledge and technology, in the literature referred to as absorptive capacity and technological capability (Görg and Greenway, 2004, p.180). There is evidence that the absorptive capacity of domestic firms is important for the presence of spillovers between foreign and local firms (p. 180). These concepts are also largely built upon the same evolutionary framework, as the proposed suited framework to study spillovers in general.

1.2 Aim and Structure of the Thesis

The aim of the thesis is to study firm level absorptive capacity in a developing country on firm level. The goal of the analysis is to give evidence of absorptive capacity, and in addition illustrate different aspects of the concept. The thesis aims to answer the following research question: is it possible to uncover latent structures among variables concerning technological innovation that can empirically illustrate absorptive capacity?

Most existing firm level studies of knowledge and capability building tend to focus on the most innovative firms placed at the technological frontier. However, these studies rarely explain how these firms have accumulated their knowledge in the first place (Figueiredo, 2006, p.3). This is one of my main motivations in the choice of a developing country. The motivation on Thailand as case will be explained in the section presenting Thailand, in the analytical chapter. Here, I will argue and exemplify why absorptive capacity
among Thai firms is highly relevant, and of crucial importance. Still, it is important to stress that the thesis does not aim to address implications for Thailand, but uses the case as an object of analysis to empirically investigate absorptive capacity.

The method applied in the empirical part of the thesis is factor analysis. The purpose is to uncover different patterns of technological innovation and, on the basis of these, analyze the firm level absorptive capacity. One important aspect is the comparison between domestic and foreign owned firms. The data is provided by the World Bank Enterprise Surveys, and covers Thailand’s manufacturing sector. The data was collected in 2004, and mainly refers to 2003 and 2002.

Following this introduction, we find a chapter on the conceptual framework of the analysis. This section is a relatively large part of the thesis, due to the fact that past research, both theoretical and empirical, is the direct inspiration for the choice of variables in the factor analysis. In addition to technological capability and absorptive capacity, this chapter includes a section about the evolutionary framework and the systematic nature of innovation. This is included on the background that these theories are the foundation and inspiration to both concepts of technological capabilities and absorptive capacity. It is a suited framework as it provides understanding of economic growth, where spillovers represent an opportunity for the less developed countries to speed technological change. It also contributes on the micro level through absorptive capacity and learning abilities.

The following chapter consists of the analysis, which starts with a short introduction to Thailand and the presentation of data. Section two of this chapter covers methodology. Section three presents the empirical analysis, and discusses the results according to theory presented in the preceding chapter. Lastly, a conclusion chapter is provided.
2. Conceptual Framework

The conceptual framework draws on the literature on technological capabilities, absorptive capacity and evolutionary economics. It starts with a presentation of technological capability. The next section consists of a review of absorptive capacity, both theoretically and empirically, as the empirical part of the paper will draw upon earlier empirical research. As absorptive capacity and technological capability builds upon the perspectives of the theories on evolutionary economics and systems of innovation, which is the subject of the third and last part of the chapter. It is important to include this subject as a part of the conceptual framework mainly to understand the innovation process, and hence the diffusion and implementation of new technology.

2.1 Technological Capabilities

Dealing with technological change in developing countries, many studies focus on technological capabilities, both on country and firm level. For the sake of my thesis, I will mainly focus on the firm level. The definitions of technological capability do vary some, but the concept is rather similar in use. Kim (1997) defines a firm’s technological capability as the “ability to make effective use of technological knowledge in efforts to assimilate, use, adapt and change existing technologies”. Technological capabilities are often used in the context of technological development in developing countries (Lall, 1992, Bell and Pavitt, 1993, Dahlman et al., 1987, Kim 1980, 1997).
One of the starting points for the concept of technological capabilities is that technology is tacit, hence it requires learning to understand the underlying principals. Firm level technological capabilities and its construct are often divided into several categories. Dahlman, et al. (1987) organize them in three main categories of innovation, investment and production. The sequence in developing technological capabilities from entirely new technology is from innovation to investment to production. Investments made directly in production often lead to minor innovations. In developing countries, this might not be the case, as they to a large degree reverse the sequence, and use production capabilities as the foundation for developing capabilities in investments and innovation. This is done through the purchase of already existing technology. The level of experience in production is of importance to develop an understanding of what is needed and possible in both new processes and products (Dahlman et al., 1987, p 764).

Another way to categorize technological capabilities that builds among others on the perspective presented above, is the classification done by Lall (1992). Capabilities are sorted into two main categories, which are investment and production capabilities. There is disagreement as regards whether production capabilities should be a part of technological capabilities or not. Bell and Pavitt (1993) stress that these two concepts should be separated. The main reason for the distinction is that they are primarily interested in the dynamics of industrialization. Production capacity is understood as the capacity to produce goods at a given level of efficiency and with given inputs. Technological capability is the capability needed to generate and manage technical change. This includes skills, knowledge, experience, institutional structures and linkages.

One obvious and important difference is that Lall (1992) does not include innovation as a separate capacity. Leaving innovation out as a separate capability, he stresses the fact
that innovation should be accepted as a broad activity covering all types of search and improvement efforts, and therefore included under investment and production capabilities. This could be seen as a statement wiping out the distinction between innovation and diffusion. Diffusion of a certain technology, in addition to the assimilation and related know how, involves changes in which the original innovation often is adapted to fit the conditions or further improve the performing standard. This process typically involves two stages to be a successful application of diffusing technology. First, as mentioned, the technology of choice may need to be improved or adapted. These activities do not fit with simple terms like technological choice or technological adaptation. This is not only the case in advanced developed countries, but its importance with regard to developing countries has been shown by Amsalem (1983), seeing the complexity and creativity of activities in the choice of technology in new textile and paper plants. Secondly, technological change may continue after the process of implementing and making the technology work under the given conditions. This post-adoption period is characterized by incremental developments and modifications, in order to make the technology work more seamless and fit it to continuing change in competitive input and product markets. The continued improvement has significant importance for cost reduction and economic gain. Amsalem (1983) shows the complexity and creativity of activities involved in the choice of technology in paper and textile industries in developing countries (Bell and Pavitt, 1993, p. 161).

The role of the adaptors and user of technology plays an important creative role in continuing technological change. It is obvious that to play the creative technological role firms need to possess the particular knowledge and skills. In developing countries, these capabilities usually have to accumulate over time before the full dynamic benefit can be realized from the technological diffusion. The accumulated capabilities must be of a deeper kind to generate a continuing path of incremental improvements. This process is not only
important for the performance and improvement of the technology in use, but also for the
ability to make changes in input and output, in response to changes in inputs and product
markets. The accumulation of skills drafted above also strengthens the firm’s capability in
the process of searching and acquiring new technology (Bell and Pavitt, 1993, p.162).

Technological change and learning are two different processes. Change includes any
way in which new technology is introduced. Learning, on the other hand, refers to any
process where the technological capabilities are increased, hence the strengthening of the
resources for generating and managing technical change. Technical change varies; it could
be a major investment project in new production facilities or plant or incremental
improvement or adaptation of existing production capacity. The new technology may to a
large degree be acquired from other firms or developed by the firm itself. In general,
technological capabilities contribute to the growing distinction between the skills needed to
operate technology and change it (p. 163-165).

2.2 Absorptive Capacity

To explore the firm level’s ability to exploit external knowledge it is also very useful to
draw on the concept of absorptive capacity, as it more deeply contributes in the building of
these capabilities compared, to literature on technological capability. When we look at the
two concepts technological ability and absorptive capacity, there are striking similarities,
and they could be treated as the same concept (Kim, 1997, p.4). They both focus on the
ability to take advantage of external knowledge. Technological capability is more focused
directly on technological change, but there is no reason not to draw on both, when analyzing
firms’ capability to use external knowledge. Narula (2003, p. 69) states that absorptive
capacity is a subset of technological capability, as it includes the ability to generate new
technologies through non-imitative means. I do not find this classification very useful, as I want to use a wider understanding of absorptive capacity that goes beyond the ability to successfully implement new technology.

The concept of absorptive capacity is a multilevel and transdisciplinary concept (Van den Bosch et al., 2003, p. 3), as the research on absorptive capacity is diverse when it comes both to the level of analysis and the theoretical perspectives. The use of the concept ranges from individual to firm level, which was the perspective initially used by Cohen and Levinthal (1989, 1990), all the way to a country level, used on industries and regions (Van den Bosch, et al., 2005, p.7). These different levels cannot be treated separately, as they are intertwined; a nation’s level depends on its organizations, and an organization’s levels depend on the individual (Schmidt, 2005, p. 2). Neither can the different levels be aggregated from another, as organizations and their abilities are more than just the sum of those working there. I will mostly use firm level literature since this is the level of my analysis. The different theoretical perspectives include strategic management, technology management, international business and organizational economics. The diversity in literature and use of absorptive capacity make it a difficult concept to work with, as regards definitions, components, antecedents and outcomes (Zahra and George, 2002, p. 185).

The perhaps most widely used definition is given by Cohen and Levinthal (1990, 1989; see Zahra and George 2002, p. 186) which states that the absorptive capacity of firms is their ability to recognize the value of new external information, assimilate it, and apply it to commercial ends (Cohen and Levinthal 1990, p. 128). In their article from 1989, they define it as the ability to identify, assimilate and exploit knowledge from the environment (Cohen and Levinthal, 1989, p. 569). Not many studies have made fundamental changes to their definitions of the concept despite of the wide application of the concept (Schmidt,
Zahra and George (2002) build on the original definition, but see absorptive capacity as a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability. Others again define absorptive capacity as the capability to learn and solve problems. Work on the interorganizational level has defined the relative absorptive capacity as the ability to learn from another firm, resembling a teacher-student relationship, where the ability to learn from another firm is dependent on similarities between the firms’ knowledge base, organizational structure and compensation policies and their dominant logic (Lane and Lubatkin, 1998). Again this touches upon some of the fundamentals of the approaches to study possibilities for firms learning from each other, outside the normal market channels, namely the importance for a common “language”, the similarities between the actors, that enable them to take advantages from each other.

To understand the construct of absorptive capacity, I find it very useful to draw on the article “Two Faces of R&D” by Cohen and Levinthal (1989). It uses a model that includes the “second face” of research and development which is the positive effect on the ability to identify, assimilate, and exploit knowledge from the environment, the absorptive capacity.

$$z_t = M_t + \gamma(\sum_{j \neq i} M_j + T)$$

In short, the model says that the firm’s stock of knowledge \(z\) is built upon \(M\) which is its investments in R&D and a fraction of knowledge in the public domain. This knowledge consists of intra industry spillovers \(\theta\), which is built by other firms’ investment in research and development \(M_j\). In addition, extra industry knowledge \(T\) contributes. The effect of these two together represented by \(\gamma\) is the firm’s absorptive capacity, namely the degree of
the external knowledge in the public domain that the firms are able to assimilate and exploit. The absorptive capacity, $\gamma_i = \gamma(M_i, \beta)$, is a construct of firms’ investment in research and development $M_i$ and the characteristics of outside knowledge $\beta$, which make R&D more or less critical to the development and maintenance of the firms’ absorptive capacity. If outside knowledge is targeted to a firm’s need, the firm’s own effort in R&D becomes more important to recognize and exploit the knowledge. This could be linked to the catch up phenomenon, but it takes it one step further. If knowledge is to a less degree targeted, research and development is a helping factor to understand the construct of more basic knowledge, for example basic research provided by a university.

Cohen and Levinthal (1990) underline the importance of prior knowledge as a key source of absorptive capacity. They clearly state that the concept can be developed best
through an examination of the cognitive structure underlying learning (Cohen and Levinthal, 1990, p. 129). This is also a good starting point in the search of the underlying building blocks of absorptive capacity. The reasoning behind is that an organization needs prior knowledge to take in use new knowledge, just as an individual who has prior related knowledge learns easier. Problem solving skills are developed similarly, but represent a capacity to create new knowledge, while learning capabilities involve the development of the capacity to assimilate existing knowledge (p. 130). A first and important building block is identified as the individual’s related prior knowledge. This does not mean that it is sufficient to just expose the individual to this knowledge; it is required effort to secure storage of knowledge. The diversity of knowledge is also important, as there might be uncertainty regarding which knowledge that potentially can be of use (p.131). The diversity argument can be seen in relation with the argument presented earlier in the chapter concerning less targeted knowledge. It requires a higher level of research and development investment by the firm, as this not only secure the understanding of more basic research, but also enables the firm to recognize useful knowledge with larger diversity. While we have now covered the first and most important construction part of absorptive capacity, the next paragraph will focus on the organizational and inter organizational aspects.

The second big cluster of building blocks of absorptive capacity concerns the organizational aspects. Several authors stress the fact that the absorptive capacity of a firm is not simply the aggregated level of all its employees (p. 132). Absorptive capacity also has distinct organizational aspects. This relates to communications and interaction both between the firm and the environment providing the external knowledge, and also the communication within the firm. This is also to some extent dependent on the individuals within the firm, as they stand in the interface of either the external source of knowledge or of the subunits of the firm. This function may be held by a large part of the firm or by individuals, and are referred
to as gatekeepers. Their role is to translate the information and knowledge that due to its complexity is hard to grasp to the employees working in the relevant departments. Contrastively, if the information is less advanced or related to ongoing activity, their role is less important, but it still relieves others from having to monitor the environment (Cohen and Levinthal, 1990, pp. 131-132). In addition, it could be argued that having a gatekeeper function may secure a wider input of knowledge, compared to a situation where ongoing researchers that are occupied with a certain project, have to “step out” of their work and be open to other influences than those regarding their work directly. The internal information flow and the receivers of the gatekeeper’s information are of importance too, as they also must have some relevant background knowledge, depending on the level of knowledge to be communicated. So the absorptive capacity of the gatekeeper does not constitute the absorptive capacity of the firm or her unit of the firm (p. 132). There can be a trade off between the efficiency in the internal communication and part of the firm’s ability to absorb knowledge from another part of the firm or the external environment. This is referred to as inward versus outward looking absorptive capacity. Still both are important for effective organizational learning. As stated earlier, diversity in knowledge within the organization is important to secure diversity in search for knowledge, linkages and associations, but it is important that the relevant actors possess some minimum of overlap in their knowledge to secure the ability to communicate (p. 133).

It is not only the communication and level of knowledge between the gatekeeper and relevant units that are important internal linkages, the cooperation and communication between different departments, such as for instance design and manufacturing, are also of relevance. This is for example suggested as one of the main reasons for the relative success of the Japanese firms in moving production quickly and effectively between design, development and production (Cohen and Levinthal, 1990, p. 134).
Many studies within the field follow this construction presented by Cohen and Levinthal, but there are several contributions which extend and modify the antecedents of absorptive capacity. Zahra and George (2001) give four dimensions of absorptive capacity, in contrast to Cohen and Levinthal’s original three; value, assimilate and apply new knowledge (Van den Bossch et al., 2003, p.5). These four are: acquisition, assimilation, transformation and exploitation. In addition, they distinguish between potential and released absorptive capacity. Potential capacity makes the firm receptive to acquiring an assimilation of external knowledge and it captures the first part of Cohen and Levinthal’s definition concerning the valuation and acquiring of external knowledge. The realized absorptive capacity is a function of the firm’s ability to transform and exploit the knowledge (Zahra and George, 2001, p. 190). The efficiency is dependent on the factor between released and potential absorptive capacity.
Figure 1: Zahra and George’s Model of Absorptive Capacity.

Figure 1
A Model of ACAP


Zahra and George view the construction of absorptive capacity as largely dependent on the external sources of knowledge and experience, in addition to relevant prior knowledge. “A firm’s exposure to knowledge within its environment will influence decision making and the development of future capabilities” (Zahra and George, 2001, p. 191). These include acquisitions and purchasing, through licensing and contractual agreements. By stating this, Zahra and George accept that absorptive capacity can be bought as it comes with the external knowledge. This stands in contrast with the work of Cohen and Levinthal, which states that the effects of hiring new personnel, contracting for consultant services and corporate acquisition are limited. The reasoning behind is the firm’s specific nature of knowledge regarding product and process innovation (p. 191). The other main component is
experience, which defines the locus of a firm’s searching ground, due to the observation that firms search in areas where they have experienced success in the past. It influences the development of path dependent capabilities concerning both acquisition and assimilation of external knowledge (Zahra and George 2001, p. 193). The two concepts above are expected to be moderated by activation triggers. These are events that encourage or compel a firm to respond to specific internal or external stimuli. Negative incidents could stimuli learning. Examples of internal stimuli could for instance be organizational changes as mergers. External stimuli concerns incidents that effects the future of the industry the given firm is operating in, for instance radical innovation or related policy changes. These triggers influence the relationship between the two components, external sources of knowledge and experience. The sources of the trigger influenced the locus of search for external sources of knowledge, and the intensity of the trigger will effect the investment in the requisite acquisition and assimilation capabilities (p. 194).

As can be observed from the figure, social integration mechanisms influence the gap between potential and released absorptive capacity. Hence, it has an effect on the earlier discussed efficiency factor. Precise social integration mechanisms lower the barriers of communication/information sharing while increasing the efficiency of assimilation and transformation capabilities (p. 194).

Zahra and George argue that firms with well developed released absorptive capacity (capabilities of knowledge transformation and exploitation) are more likely to accomplish competitive advantages, due to innovation and product development superior to firms with less developed capabilities. With high level potential absorptive capacity (capabilities of knowledge acquisition and assimilation) the firm is more likely to achieve competitive advantage, due to high flexibility in reconfiguring their resource base and timing capability
deployment at a low cost (Zahra and George, 2001, p. 196). Zahra and George’s model of absorptive capacity gives a good understanding of the concept. All in all, it is still relatively similar to Cohen and Levinthal’s work.

Much of the empirical work conducted on firm level is concerned with the relationship between absorptive capacity and different firms’ performance. Cohen and Levinthal (1990) relate absorptive capacity to innovation activities and innovation performance, using R&D as a measure of absorptive capacity. They state that R&D builds a capacity to assimilate and exploit new knowledge. Stock et al. (2001) relate absorptive capacity to new product development. Using the same measure as Cohen and Levinthal, they find an inverted u-curve relationship between absorptive capacity and efficiency in developing new products. Deeds (2001) finds a positive relationship between absorptive capacity and entrepreneurial wealth. Becker and Peters (2000) also apply R&D as a measure, but several indicators, the existence of R&D department and R&D activities carried out continuously. Among other aspects they conclude that there is a positive relation between absorptive capacity and output of innovation.

The empirical work on absorptive and organizational outcome, like innovation performance, is problematic as the measures used for absorptive capacity are simplified and reduced down to for instance R&D intensity. If this is an insufficient measure it is natural to question the conclusion of these studies. Observed from the empirical worked listed, R&D measures in different forms dominate the empirical research on absorptive capacity.

“The empirical measurement of the absorptive capacity of firms is difficult, due to the lack of data” (Becker and Peters 2000, p. 11). It is hard to construct good measures of

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2 See Nieto and Quevedo (2005), table 3: research on the variable absorptive capacity, for an overview.
absorptive capacity, to a large degree due to the fuzziness of the concept, and the rather advanced construct of the dynamic capability that absorptive capacity is. The measurement is the main problem addressing absorptive capacity empirically.

As mentioned, the method most widely used to estimate firm level absorptive capacity is to use one or several measures reflecting the level of R&D conducted in the firm. This includes R&D staff, R&D departments and R&D investment (Becker and Peters, 2000, Veugelers, 1997, Cohen and Levinthal, 1990, Stock et al., 2001). Cohen and Levinthal use R&D relatively to sales as a measure of absorptive capacity. They argue that this is a sufficient indicator, since a firm’s ability to exploit external knowledge often is a byproduct of its own R&D (Cohen and Levinthal, 1990, p. 139). It is a paradox that the literature that contributes so much to the understanding of the construct of absorptive capacity marginalizes it to such an extent in its empirical work. On the other hand, understandable as a aim of the article is to stress the fact that the existence of spillovers may have a positive effect on investment in R&D. Measures only based on R&D does not necessary say much about a firm’s ability to make use of external knowledge. For instance, researchers may be totally focused on their own work, have an extremely narrow focus, and a research lab may be completely closed (Knudsen, et al 2001, p. 8). In spite of the critique of R&D measures, it is due to the construction of absorptive capacity obvious that investment in research and development contributes positively. Even if the R&D lab is completely inwardly focused, it produces knowledge that accumulates in the firm, and will probably contribute to future absorptive capacity.

The reconceptualization of absorptive capacity made by Zahra and George opens for a set of different indicators of absorptive capacity based on the direct relations with the sources of external knowledge. “We argue that successfully using such external sources of
innovation is a rather direct measure of the exploitation component of absorptive capacity. A firm which is able to pick up impulses from external parties and turn them into innovation is certainly able to exploit external knowledge; it thus possesses absorptive capacity” (Schmidt, 2005, p. 9). Following Zahra and George, linkages and cooperation with other firms is not only an indicator of a firm’s existing absorptive capacity, in the sense that firms in cooperation with others use external knowledge, but also in the building of absorptive capacity.

Schmidt (2005) is one of few that on firm level tries to empirically investigate the construct of absorptive capacity. The findings shows that the determinants of absorptive capacity differs with the types of knowledge absorbed (own industry, other industries and research institutions). The study concludes that R&D intensity does not influence absorptive capacity significantly. Schmidt (2005) is one of few contributions I have been able to identify which try to answer the question of what determines absorptive capacity. When he discusses the determinants of the concept he treats investment in R&D as a separate determinant than prior knowledge and skills. I think this is a misinterpretation of previous work, as it also emphasizes the prior knowledge and individual skills, but uses R&D as a measure on accumulating knowledge.

Other measurements used are patents and citations (Mowery et al., 1996). In addition, there is a cluster of measures used concerning the organizational and inter organizational aspect, including incentive systems, human resources and knowledge management (Lenox and King, 2004, van Den Bosch et al., 1999, and Vinding, 2006.) These measures’ relevance may easily argued be relevant according to the main theoretical approaches discussed earlier. The organizations’ absorptive capacity is among organizational and other factors dependent on their members’ capacities.
2.3 Systematic Nature of Innovation

Both the concepts of absorptive capacity and technological capacity build upon the evolutionary framework. There are some attributes with evolutionary economics that are especially important in this setting. First of all, technological knowledge is not shared equally among firms, and a firm cannot simply choose the preferred technology. Secondly, the path dependency of learning represents an important aspect. The identification of the tacit nature of much of the skills and knowledge implies that past experience is of crucial importance. This brings us to the last concept drawn from the evolutionary framework, which is the path dependency in the development of absorptive capacity. I will give a more thorough presentation of these concepts in the following paragraphs. More generally, the concepts draw on the evolutionary view of the firm and the systematic nature of innovation, as well as the evolutionary view of learning. As discussed in the introductory part, the literature on system of innovation is fitting to analyze spillovers from multinationals.

The first important aspect with evolutionary economics is a clear contrast to traditional economics, where firms are treated as homogenous actors, which can be studied under a common production function where technological knowledge is shared equally among firms. In fact, the technology can neither be imitated or transferred easily (Lall, 1992, p. 166). In general, there exists little knowledge that is a perfectly public good. Even basic publicly available knowledge may be impossible to access without the proper communication or networks. Nor is economically useful knowledge a completely private good. New technology can be costly to imitate, but if the benefits exceeds the cost, there are several ways to obtain it (Lundvall, 2004, p.27).

Within traditional microeconomics, one important aspect missing out when working under assumptions of homogeneous firms is the nature of the knowledge and the level of
knowledge. The tacit and codified nature of knowledge is of great importance for the concepts of absorptive capacity, as it relates to the transferability and the public character of knowledge. The more tacit the knowledge is, the harder it is to share among firms (Lundvall, 2004, p. 28).

In contrast, the evolutionary framework can give a better understanding of the process of spillovers from MNCs. This is mainly due to the view of firms not as isolated, static and pure economic agents, but as members of changing economic and social institutional networks (Gachino, 2007, p. 11).

Above I have briefly discussed some important aspects when theorizing on absorptive capacity that is based on the foundations of the evolutionary perspective. I will now present what I view as the most important aspects of the evolutionary framework in the context of absorptive capacity. As discussed earlier, innovation activity is usually and in most cases heavily dependent on external sources (Fagerberg, 2005, p. 12). This is also the starting point of some of the main literature on absorptive capacity done by Cohen and Levinthal (1990), stressing that outside sources of knowledge are often critical to the innovation process, and that much of the innovation results from borrowing, rather than organizations inventing themselves (Cohen and Levinthal 1990, p. 128). It is reasonable to assume that this form of innovation process, with a large degree of imitation, is even closer to the reality in developing countries, where we can observe less of the traditional alternatives to innovate (Gachino, 2007, p. 16). This, in combination with the increasing presence of foreign firms that differ from domestic in all levels, gives an even larger opportunity for imitating, and hence a larger importance of absorptive capacity. It is in this setting that we can truly appreciate the importance of absorptive capacity.
From the end of the 1980s, a series of scholarly contributions built upon the evolutionary perspective focused on the systematic aspects of innovation diffusion and the relationship to social, institutional and political factors. This literature is largely based upon the Schumpeterian logic; Schumpeter’s insistence on the cumulative and path dependent character of innovation; in combination with the finding in applied innovation research that concludes that the various stages of the innovation process tend to be filtered together in a web of feedbacks and loops (Fagerberg, 2002, p. 38-39). Different systems of innovation are characterized by their boundaries, which can be divided in three ways: spatially/geographically, sectorally (includes technological systems), and in terms of activities (Edquist, 2005, p. 199). I will focus on the national system of innovation, as my analysis focuses on one single country. In general, the national perspective is a relevant one, as nationalities differs in the structure of production system and institutional setup (Lundvall, 1992, p.13).

The concept of the national system of innovation is introduced by Freeman. In his analysis of Japan, he defines “the network of institutions in the public and private sector whose activities and interactions initiate, import, and diffuse new technology” (in Lundvall, 1992, p. 16). Nelson studies the US system. Nelson’s work to a large degree focuses on institutions, while Freeman focuses relatively more on organizations (Lundvall, 1992, p. 17). These contributions both apply a macro view, opposite to Lundvall’s book National Systems of Innovation, which is more “micro”, and focuses on learning as interactive processes (Lundvall, 1992, p. 8). In addition, Lundvall’s contribution is more theoretically oriented, and tries to develop an alternative to the neoclassical economics by placing learning, interaction and innovation at the center of the analysis (Edquist, 2005, p. 183).
The internal organization of firms is a crucial part of the innovation system. Most innovation is developed by firms, and many studies of innovation conclude with the importance of the organization on the flow of information and the learning process for innovative performance (Lundvall, 1992, p. 14). But one of the fundamental aspects of systems of innovation is the emphasis put on interaction among firms as an important aspect of innovation, as in fact innovations and technological changes often do not appear internally in one firm, but are affected by inputs, knowledge or cooperation from other actors in the economy (Fagerberg, 2005, p. 12). One of these structures is inter firm relationships. In contrast to standard neoclassical economics, these relationships are not only characterized by competition and pure markets, but also cooperation. This could for instance be user-producer relations, where feedbacks result in improving products for the user, or other forms of inter firm cooperation. The importance of other actors interacting with a firm goes beyond other firms, and includes the public sector and research institutions (Lundvall, 1992, p.14).

Learning, as addressed in the section concerning absorptive capacity, is to some extent routed in routine activities and experience. In addition, economic agents invest in their expansion of technological knowledge (p. 11). A complete and concrete evolutionary theory does not yet exist (Witt, 2006, p. 361). But compared to other theories of the firm, the evolutionary approach gives a good understanding of the nature of firms by providing explanation of how firms can be defined, through the set of routines and competencies that the firm encompasses. It explains why firms differ and thus are heterogeneous, due to their reliance on different sets of routines which are firm specific and not transferable at low cost. In addition, it provides explanation to the dynamics of firms, through firm combined mechanism of searching and the possibility of transforming a set of secondary routines into the core activity (Hölzl, 2005).
The evolutionary theory and theories on systems of innovation emphasize learning as a crucial part of innovation. In contrast to standard neoclassical economics, knowledge and technology are not available for every firm in the economy to take use of with only a fraction of cost, and firms are not heterogeneous, but differ at all levels. This opens up for a framework which allows firms to learn from one another and to take advantages of the fact that firms are heterogeneous in information and technological knowledge.

We can assume that the ability to learn from the environment, recognize and take use of external information differs largely among firms. To understand these differences, I find it useful to draw on the concept of absorptive capacity, technological capability and evolutionary economics drafted in this theoretical chapter.
3. Analysis

The analytical and main part of the thesis starts with a presentation of the country, followed by a presentation of the data, in which the chosen variables are presented and explained. Then a quick step by step introduction to factor analysis follows, including arguments for the choice taken between different procedures of factor analysis. The chapter continues with the empirical results from the analysis and a discussion of the findings.

3.1 Thailand

Thailand is a laggard in technological catching-up (Intarakumnerd et al., 2002, p. 7). For many years, Thai firms have lagged behind others in the region. In contrast to Thailand, other developing countries such as Korea, Taiwan and Singapore have more aggressive policies and intensive technological learning. Several studies from the 1980s and 1990s show that most Thai firms grow without improving their technological capabilities in the long run, indicating slow technological learning (Intarakumnerd, 2006, p. 106). Only a minority of firms, mainly large subsidiaries multinationals, have capability in R&D. For the majority of small and medium enterprises, the key focus is still to build basic operational, craft and technological capabilities for the purpose of efficiently acquiring, assimilating and incrementally upgrading relatively standard technology (p. 107).

In countries like Taiwan and Korea industrialization and technological catching up started approximately simultaneously as in Thailand. They have been more successful in increasing their absorptive capacity (p. 107). More intense competition in the market, especially from China, has to some extent led to a change in the behavior of Thai firms. For
instance, a growing interest in increasing R&D spending and start up firms that rely on their own design, engineering or development activities, indicate growing entrepreneurial activity (Intarakumnerd, 2006, p.108). In the years following the financial crisis in 1997-1998, there has been a deepening of the technological intensity in the manufacturing service, through implementation of more sophisticated production methods absorbed from abroad (NESDB and World Bank, 2008, p. 1)

The until recently negative development stands in contrast to Thailand’s rather impressive economic growth the last 40 years, between 1960 and 2004 GDP, increased in size from $9 billion to over $150 billion, and per capita from $332 to $2356 in constant 2000 prices (NESDB and World Bank, 2008, p. 1). The most important sector contributing to the economic growth has been manufacturing (p. 3). Thailand’s policies distinguish the Thai from the newly industrialized economies (NIEs), with less focus on state activism. Still, Thailand and the NIEs share the export orientation. In general, the resource based and labor intensive exports have decreased, while the scientific and differentiated have increased (Intarakumnerd, 2006, p. 100).

To study absorptive capacity using the Thailand case is rewarding in several ways. Thailand in this setting is a very interesting as it performs relatively badly on absorptive capacity compared to other NIEs. As the “class loser”, these capabilities may be even more important for Thailand to develop rapidly. On the background of the increasing competition, combined with the fact stressed by Intarakumnerd (2006), that Thailand is behind its competitors when it comes to technological capabilities, the stakes are high and rising for Thailand, as it cannot avoid the “technological arms race” (NESDB and World Bank, 2008, p.1). If Thai firms first fall behind, the risk for a negative economic spiral is present, driving away leading MNCs and talented workers. Either way, the growth is likely to suffer. There is
a risk that Thailand will suffer the same fate as many middle income countries in Latin America and the Middle East, where countries experience economic stagnation. Thai growth is still heavily dependent on capital and labor inputs instead of growth in the total factor productivity. If Thailand wants to maintain or improve its global competitiveness, it must move towards a knowledge and technology based economy (NESDB and World Bank, 2008, p.34).

There are several factors that are important to enhance Thailand’s competitiveness. The report “Towards a Knowledge Economy in Thailand” have several recommendations that includes the improvement of linkages between firms and research institutions, increasing availability of science and engineering skills, improving education, and increasing investment in research and development among firms (NESDB and World Bank, 2008). These are all aspects that touch upon absorptive capacity, and illustrate that absorptive capacity among Thai firms makes a highly relevant topic of great importance if the Thai manufacturing industry is going to be able to experience progress concerning technological development. This, combined with issues addressed in the introduction concerning technological spillovers as a growth opportunity for developing countries, are the main motivations for the selection of Thailand as the case.

3.2 Data

The data applied in the analysis is provided by the World Bank Enterprise Surveys, which began in 2002. They now cover about 75,000 firms in 105 developing countries. The surveys are conducted by private contractors, in order to secure the greatest degree of participation, integrity and confidence in the quality of the data (World Bank Enterprise Surveys, 2004).
The survey in Thailand was conducted by the Thailand Productivity Institute with the assistance of the World Bank. It was conducted under the supervision of the National Economic and Social Development Board (NESDB). The survey provides some good measures of innovation in less developed countries. The survey more and less includes the most important elements worth emphasizing when studying aspects regarding innovation in developing countries, which is acquisition of embodied technology and minor incremental changes (Intarakumnerd, 2007). The aspect the survey fails to cover is organizational change. This is of course a weakness with the analysis. The lack of firm level data in developing countries is still a challenge.

The number of Thai firms in the survey is 1385, which all represent the manufacturing sector. It covers eight industries: food processing, textile, clothing, automotive parts, electronics and electrical appliance, rubber and plastic, wood products and furniture, and machinery and equipment. In the analysis, 202 cases are excluded due to missing information. Thus, the total number of firms ended on 1183.
Table 1: Overview of Variables/ Questions Applied in the Factor Analysis

<table>
<thead>
<tr>
<th>Abbreviation applied below</th>
<th>Question</th>
<th>Question no. in survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hire_rdstaff</td>
<td>Did (KE) employ staff exclusively for design/ doing innovation/ R&amp;D in 2002-2003?</td>
<td>iii_12</td>
</tr>
<tr>
<td>Planning_intro_new_prod</td>
<td>Are you planning to introduce new designs/ products in the next two years (2004-2005)?</td>
<td>iii_15</td>
</tr>
<tr>
<td>Uni_research_ins</td>
<td>If technological innovations were developed or adapted locally, did you seek help/ collaboration with: Universities and/or research institutions?</td>
<td>iii_18_2, iii_18_3</td>
</tr>
<tr>
<td>Training</td>
<td>Did your plant run formal training programs for its employees during the fiscal year or 2002-2003 and/ or Have you sent your workers for training In a Skill Development institute in the past three years?</td>
<td>iv_11, iv_12</td>
</tr>
<tr>
<td>Edu_some_university</td>
<td>What percent of your workforce at your establishment have the following education level? More than 12 years (some university or higher)</td>
<td>x_19_c1</td>
</tr>
<tr>
<td>Iso_standards</td>
<td>Has your firm received any ISO (e.g. 9000, 9002 or 1400) certification</td>
<td>iii_26</td>
</tr>
<tr>
<td>Uppgr_mach</td>
<td>Upgraded your machinery and equipment in the last 2 years</td>
<td>iii_16_1</td>
</tr>
<tr>
<td>Entered_new_mark</td>
<td>Entered new markets due to process or product improvements in quality or cost</td>
<td>iii_16_2</td>
</tr>
<tr>
<td>Patents_utilitymodels</td>
<td>Filed any patens/ utility models or copyright materials</td>
<td>iii_16_3</td>
</tr>
<tr>
<td>Major_new_prodline</td>
<td>Developed a major new product line</td>
<td>iii_16_4</td>
</tr>
<tr>
<td>Uppgr_prodline</td>
<td>Upgraded existing product line</td>
<td>iii_16_5</td>
</tr>
<tr>
<td>Intro_newtech</td>
<td>Introduced new technology that has substantially changed the way the main product is produced</td>
<td>iii_16_6</td>
</tr>
</tbody>
</table>

The survey questions whether or not the firms have undertaken certain initiatives in the last two years (2002-2003). The first seven variables included in the analysis all concern technological innovation. These measures are very important for the analysis in several ways. First, innovation performance is an important outcome of absorptive capacity. In
addition, these activities build capabilities that are important in the construction of absorptive capacity.

Uppgr_ mach, concerns the upgrade of machinery and equipment. This variable tells us something about the firms’ ability to adapt and upgrade their production methods. It is of obvious importance as this is one of the main focuses in the literature on absorptive capacity especially within the work on technological capability.

Entered _new_ mark measures whether the firms have entered new markets due to process or product improvements in quality or cost. It is reasonable to assume that to enter a whole new market, due to cost or quality, more than incremental changes in one or both cost or quality are required; it requires a more substantial change.

Patents_utilitymodels concerns patents/utility models and copyrighted material. Patenting is in general widely used as a measure in innovation studies. Empirical research on absorptive capacity also includes patents and property rights as a measure (for instance Mowery et al., 1996). Patents and copyright is not only interesting as a measure of innovative behavior. It also touches upon the ground foundation of absorptive capacity as the two faces of R&D. As discussed in the theoretical framework, the existence of spillovers has a supposedly negative and positive effect on firm’s investment in R&D. From the data these subjects can be illustrated.  

3 Question iii.25.1 asks whether or not firms would invest more in R&D, if international property rights laws were stronger (hence, lower spillovers, lower possibility of others to take use of there technology and visa versa). The mean among firms in the survey is 0.51, a very interesting result as it clearly shows that there are two effects ref. Cohen and Levinthal two faces of R&D. Question iii.25.2 asks whether stronger intellectual property rights would make it more costly to acquire new technology. According to theories discussed in the theoretical framework this is expected. The mean among the surveyed firms is 0.61, which says that for a “majority” of the firms it is more important to acquire technology through imitation etc. than to protect the technology they developed themselves.
Uppgra_prodline, Major_new_prodline, and Planning_intro_new_prodline all concern direct product innovation. One of them is more incremental and concerns the upgrade of the existing product line. Another concerns the introduction of a major new product line. The third regards the future, and asks the firms if they plan to introduce new products or designs within the next two years.

Intro_newtech concerns technological innovation, and deals with the introduction of new technology that has substantially changed the way the main product is produced. This variable captures process innovation/ process engineering.

Hire_rdstaff relates to investment in research and development. The applied question asks whether the firms have hired staff exclusively for design/ doing innovation/ research and development in the last two years (2002-2003). Usually in literature on absorptive capacity and innovation performance, the R&D measure is R&D expenditures, which is often seen relatively to total expenditures or sales. For the Thai firms, the expenditures on R&D are suspiciously low, and they do not contribute much to the analysis. Another problem with R&D expenditures as a measure is that they do not guarantee any internal research and development activities at all, as everything could be outsourced. Cohen and Levinthal (1990, p.135) conclude that outsourced contributions to absorptive capacity are less effective than those developed internally. By contrast, the measure I have chosen, measures internal activity, and it also captures the gatekeeper role (Cohen and Levinthal, 1990, p. 132).

I have also included a variable concerning collaboration with external actors. The firms were asked whether they sought help from or collaborated with universities or other research institutions, if some of the technological innovations mentioned above were
developed locally. 4 Uni_research_ins is a combination of two questions. The first regards universities, and the second, research institutions. In my analysis it is natural to treat these as one variable. This variable, combined with the ones on technological innovation, say something about the firms’ openness towards other actors in the economy, and the eventual benefit of such interaction. It could also be seen in the light of linkages capabilities (Lall, 1992, p. 168).

The variable Iso_standards, asks whether the firms have received any ISO certification (e.g. 900, 9002 or 14,000). As the understanding of the concept of absorptive capacity stresses the importance of prior practices in the decision to implement new practices (King and Lennox, 2001), the implementation of such standards could tell us something about openness towards outside production and management standards. The existence of ISO standards in production secures a certain level of quality.

In addition, I have included one variable that measures whether or not the firms provide training for the staff. The variable training is made up by two questions in the survey. The first is: did your plant run formal training programs for your employees during the fiscal year of 2002-2003? And the second: have you sent your workers for training in a skill development institute in the past three years? This variable is relevant, since employee training is an active investment in the firms’ absorptive capacity. In addition, it could be argued that this variable indicates something about the individuals’ level of knowledge. it also directly contributes to the individual’s absorptive capacity.

The last variable included also concerns the employees and the human capital stock. Here, in contrast to the preceding variable, the knowledge the workers have before being

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4 In addition to universities and research institutions, I tested collaboration with other firms. The variable did not contribute in any significant form to the factor structure.
employed is measured. Edu_some_university measures the percent of the workforce at the establishment that have more than 12 years of education (some university). This measure is meant to say something about the level of knowledge at an individual level, which has implications for the level of knowledge in the firm. This knowledge differs from the kind of knowledge represented by employer training, as it is prior knowledge, and not necessary specific for the firm.

As demonstrated in the above explanation of the included variables, they measure interesting characteristics about the firms included in the survey. But it is only when they are analyzed in relations with one another that it is possible to say something about the processes of technological innovations. All the variables are dummies, with the exception of Edu_some_university, which is the percent of the workforce with minimum 12 years (some University level) education.

### 3.3 Factor analysis

Factor analysis is widely used among behavioral, health and psychology studies. The reason for the growing popularity of the factor analysis among these fields of science is the fact that variables within these fields tend to be less defined compared to more well-established sciences, where they are precisely defined and widely accepted as important variables to study. In the case of absorptive capacity, researchers do not agree in detail on the construct, importance or the outcome, nor is the nature of the relationship between concerning variables clearly defined (Comrey and Lee, 1992, p.1).

The main reason for choosing factor analysis as the statistical method in the thesis is that its results can help understand the complex and poorly defined concept of absorptive capacity. Instead of choosing a measurement of absorptive capacity, for instance R&D
intensity and relate it to innovation, a factor analysis is more “open” when it comes to results.

Factor analysis is a collection of procedures for analyzing relations among a set of random variables. It could be argued that the existence of clusters of large correlation coefficients between subsets of variables implies that the variables measure aspects of the same underlying factor (Field, 2000, p. 423). So the purpose of factor analysis is to find the correlations among \( n \) variables, by postulating a set of common factors, which should be considerable fewer than the number of \( n \) (Cureton et al., 1983, p. 2).

The basic idea behind factor analysis is to find underlying latent factors in a given set of variables (Jöreskog, 2007, p. 47). The factor analysis is used to explore the underlying structures of variables regarding innovation among the firms in the survey.

The factor method used in the analysis is principal axes factoring, which is the most widely used method. This method gives a least-squares solution (Curenton and D’agostiono, 1983, p.137). The method seeks the least number of factors which can account for the common variance among the variables.

There are two main types of factor analysis, exploratory and confirmatory. In exploratory analysis the researcher have no assumption on the numbers of factors that explains the correlation. If there is an assumption on the number the analysis is confirmatory (Ulleberg and Nordvik, 2001, p. 12). This analysis is of the exploratory sort as I do not have any assumptive structure in advance. However, I had to choose which variables to include in the analysis, as I could not include all in the survey.
To make the output more understandable and ease the interpretation, it is common to use a method of rotation. The sum of eigenvalues (characteristic roots)\(^5\) is not affected, but the eigenvalues are altered and the factor loading changes. There are two main categories of rotation methods, oblique and orthogonal. The main difference is that the oblique rotation allows the factors to be correlated, while orthogonal rotation does not, and the correlation between one and any other factor is zero (pp. 17-21).

In spite of the fact that orthogonal rotation would give an even clearer factor structure and ease the interpretation of the factors, I have chosen oblique rotation. The reason for this is that I believe the result is closer and gives a more accurate description of the firms. In real life, it is not possible to rule that the factors have an effect on each other. And as I will present later, they have a relatively large correlation. The analysis deploys the rotation method direct oblique rotation, which is the most widely used oblique rotation method.

The selection of the number of factors within the analysis is not in any way given. The goal is to extract a number of factors that explains the correlation among the variables. The analysis of this project concludes with three factors. How many factors that should be extracted has no defined clear answer, and to a large extend is the researcher’s choice. There is no unique way to determine the numbers of factors (Jöreskog, 2007, p. 49). There are several guidelines for extracting factors, which can lead to problems as there would be different results depending on method of choice. The most common resides on the eigenvalue of the factors. A common rule of thumb, which is much used, is the Kaiser criteria, which states that all factors with eigenvalues under 1.0 should be excluded. This

\(^5\) The eigenvalue for a given factor gives the variance in all variables explained by the given factor. The ratio gives explanatory importance of the factors with respect to the variables. If a factors eigenvalue is high, it contributes to a large degree to the variance among the variables (Ulleberg and Nordvik 2001, p. 8).
method yield problems when several factors have eigenvalues around one (Ulleberg and Nordvik, 2001, p. 14). Take for example five factors with the eigenvalues 3.00, 1.10, 0.99, 0.58, and 0.47. In this case, it would be bad for the analysis to exclude the third factor.

The three factors extracted in the analysis have the values 2.59, 1.35, and 1.27 and are the only ones with a value above 1.0. In addition, the limitation of factors has been done on the basis of the scree plot. Furthermore, the factors below the eigenvalue 1 have less than three high interpretable loadings, which mean that they should not be included, according to rule of thumb. To sum up, the extraction of the three factors satisfies three guidelines for factor extraction. Given the variables and result, I am sure that the number of factors extracted is reasonable.

A weakness which is very relevant concerning my analysis is the problems regarding selection bias. Due to the fuzziness of the concept absorptive capacity, it is natural to assume that it is possible that some irrelevant variables are included, and some relevant could be excluded. I have tried to include variables suggested as relevant by previous research and the theoretical framework of the thesis within the limitations of the survey. I find this as a very satisfactory approach and one of the main strengths using factor analysis as a method, as it allows me to include several aspects of the concept of absorptive capacity and analyze whether there is an underlying firm ability explaining the variables.

According to the theoretical framework outlined in chapter two, one important aspect is missing in the variables. The survey did not provide any measure of the internal mechanisms relating to absorptive capacity.

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6 Scree plot: A graphic presentation of all the factors’ eigenvalue. On the basis of this, the number of factors could be extracted on the basis of the researcher’s judgment (Ulleberg and Nordvik, 2001, p. 14).
Compared to other studies on absorptive capacity, this analysis includes relatively few variables concerning direct investment in research and development. First of all, this is due to the fact that only a small fraction of manufacturing firms in the developing world has high R&D budgets. Hence it is not natural to assume that firms in developing countries accumulate knowledge over time like firms at the technological frontier in the developed world (Gachino, 2007, p. 24). It could be argued that the analysis should include one variable, for instance R&D divided on sale, since this is the most widely used in previous research. I tested the variable in the model, and it contributed to the same factor as the variable concerning R&D I ended up using (the hiring of exclusively R&D and design employees), but it had a much lower impact. This may imply that the gatekeeper function of R&D personnel has an impact, and that this function is of importance. Another aspect explaining the differences, is that R&D expenditures does not say whether or not the R&D is bought from other actors, and hence have a lower impact on the absorptive capacity compared to internal R&D activities, as the other variable clearly capture. On the other hand, some of the reason could be the overall low expenditure on R&D among the Thai firms.

3.4 Results

The results of the factor analysis give us three factors that in total explain 43 percent of the variance among the variables.

Table 2: Pattern and Structure Matrix
3.4.1 First Factor: R&D

The first factor consists of the employment of staff exclusively for design and R&D, plans to introduce new products within the next two years, entering of new markets due to process or product improvement in quality or cost, filled in patents/utility models or copyright protected material and the cooperation with universities and/or research institutions regarding locally developed technological innovations, and to some degree the introduction of a major new product line.

This factor captures obvious processes, where efforts in research and development, combined with linkage capabilities, result in entering new markets due to product improvement in quality or cost, the plans to introduce new products, as well as patents/
utility models. This factor represents a relatively high and advanced part of the product engineering. It measures innovation, both on the input side, represented by investment in personnel exclusively hired to conduct research, development and new design. In addition, the same factor seems to explain the interaction between the firms and universities and other research institutions.

It measures traditional innovation on the product side, where a part of the input is research based, and the outcome is new products and patent/ utility models. As the research and innovation activities are at an advanced level, as we can observe in this factor, the firms seek universities and research institutions for input and help. It is reasonable to assume that the improvements in quality or cost are of substantial importance as the result is the entrance of a completely new market for the firm.

To return to the theoretical dimension, Cohen and Levinthal focus among other things on the structure of communication between the firm and external environment. The element of cooperation in the innovation process is a key element when it comes to the systematic nature of innovation, and as discussed in the theoretical part of the thesis, most innovation is done in interaction with other actors in the economy. In the present analysis, the result shows that collaboration with universities and research institutions are part of the same factor as the more advanced product innovation. This does not only support the literature on the systematic nature of innovation process, but it also show the importance of a level of knowledge to take fully use of information from other actors in the economy throughout the innovation process. Linkages like this, with active cooperation on innovation, presuppose a relatively high level of absorptive capacity. It also builds absorptive capacity as the firm has a direct channel to new knowledge. In the setting of Zahra and George’s framework for absorptive capacity, this touches upon one of the two main antecedents of
potential absorptive capacity, namely the external sources and knowledge complementary. They predict that the greater a firm’s exposure to diverse and complementary external sources of knowledge, the greater is the firm’s opportunity to develop potential absorptive capacity (Zahra and George, 2002, p.193).

In the interaction with outside environments like universities or research institutions the person in the interface of the firm and the university, or at the interface between the subunits of the firm, is of crucial importance, and the firm’s absorptive capacity is dependent upon it (Cohen and Levinthal, 1990, p.132). It is possible to argue that the gatekeeper concept maybe one of the aspects captured in this factor, as it includes the variable concerning human resources hired exclusively to conduct R&D and new design. In manufacturing firms the gatekeeper role may be of great importance, as it is not plausible to expect that the average worker will have the sufficient technological knowledge, or the opportunity to monitor the environment and translate information. The existence of highly skilled employees in the organization is of crucial importance to have cooperation and interaction with universities and research institutions to be productive and successful. These aspects touch upon one of the basic concepts and most elementary level of absorptive capacity, which is a shared common language (Cohen and Levinthal, 1990, p. 128). In the setting of less advanced firms, with limited experience with research and development, the size of the gap in the level of knowledge possessed by the firm and the one by the university and research institution could hinder cooperation.

### 3.4.2 Second Factor: Embodied Production Technology

The second factor consists of the following qualities: upgrading of machinery and equipment, the introduction of new technology that substantially changed the way the main product is produced, upgrading existing product line and the development of a major new
product line. This factor includes the introduction of new production technology and the upgrade of machinery and equipment, which both represent technological change on the firm level. Technical change can be distinguished into two types. One involves the incorporation of new technology in relatively large lumps through investment in new or substantially expanded production facilities. The second involves the continuing incorporation of new technology in the production facilities (Bell and Pavitt, 1993, p.164). Both technical changes are represented in the factor trough, the introduction of new technology that substantially change the way the main product is produced and the upgrade of machinery and equipment.

Linking to the literature, it is possible to say that this factor to a large degree represents process engineering up to an intermediate level (equipment stretching, process adaptation and cost saving, introducing new technology (licensing)). It mainly consists of process innovation and process engineering, but it also includes variables concerning product innovation, mainly incremental.

Investments in production capacity through upgrades of machinery/ equipment and the introduction of new production technology which both have relatively high loading on this factor represent technological change in the firm. The factor does not only capture this process innovation, but interestingly also innovation on the product side, through upgrade of existing product line, and to some degree the introduction of new products. The factor illustrates important aspects in the literature on absorptive capacity and diffusion of technology. The diffusion of technology goes beyond the acquisition of machinery; it also involves continuing often incremental technical change (Bell and Pavitt, 1993, p. 160). The period after the technology is successfully adopted incorporates a stream of incremental

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7 Products new to the firm, not necessary new to the market.
changes to further improve the technology and mold it to continuing change in input and product markets. To take full benefit of the newly introduced technology, the firm has to possess the particular kinds of knowledge to play the technologically creative role (Bell and Pavitt, 1993, p.161).

The kind of reasoning above falls directly under the definition of absorptive capacity. The level of prior knowledge is crucial for the level of success and improvement the new technology and machinery brings. From the second factor we can observe that investment in technology brings incremental improvement in the existing product line. The fact that technological learning is cumulative does not guaranty that all technological change always is incremental. As we can observe, the factor also consist of the introduction of technology that substantially change the way the firms’ main product line is produced. Again, this could be linked to absorptive capacity. The cumulative learning process enables firms to cross the discontinuing of incremental changes. This factor illustrates that the diffusion of technology goes beyond the acquisition of machinery. It involves continuing incremental changes.

Production engineering is in a wide sense the ability to obtain and act on the information required to optimize the operations/ production (Dahlman et al., 1987, p. 763). According to Dahlman et al. this information stems from raw material control, trouble shooting, quality control and the adaptation of process and production according to the circumstances. Problem solving and trouble shooting are processes which are dependent on prior learning experience, and these skills develop in the same way as learning capabilities (Cohen and Levinthal, 1990, p.130).

Based on these observations, it is possible to argue that absorptive capacity not only is important in the process of acquiring knowledge that lead to something completely new, but also regarding process innovation and incremental improvement in products. The
creative role adopters of production technology play in the stages of technological change is dependent on the firm’s absorptive capacity. A firm with high capabilities can exploit the new technology to a larger degree. The benefit is not only incremental changes in production and products, but it is expected that the capabilities represented in the factor also strengthens the organization’s capabilities to seek out and acquire technologies from other firms and economies.

The process captured in this factor seems to build on prior knowledge and experience, which involves low risk and uncertainty compared to research based activities. The factor captures the dynamic benefits from technology diffusion. Firms must possess deeper forms of knowledge, skill and experience to generate paths of continuing incremental change (Bell and Pavitt, 1993, p.162).

3.4.3 Third Factor: Standards

The last factor consists mainly of the implementation of ISO standards. It also includes level of education in the firm, and the presence of official training programs for the staff. Employee training could be a tool to enhance an organization’s absorptive capacity. The level of education can in some ways reflect the level of knowledge in the organization. The implementation of ISO standards may imply openness to the external environment. Seen in relation with absorptive capacity, this factor captures a low form of prior related knowledge. It could be argued that the ISO standards capture aspects of basic absorptive capacity, through basic levels of process and product engineering, which includes quality control and assimilation of product design (Lall, 1992, p.167).

After now identifying three factors that clearly relate to the theoretical concept of absorptive capacity, the chapter will comment on relevant dimensions of the factors, having
in mind that they represent three different aspects of the same concept. Furthermore, the last
sections consist of a presentation of factor loading according to ownership, size and industry,

3.4.4 Factor Comparison

Dealing with absorptive capacity, it is natural to look at the source of knowledge that
contributes to the development of products and processes, in addition to experience stressed
as the important building blocks of absorptive capacity. In the two factors, R&D and
embodied production technology, there are clear differences. Knowledge is represented in all
the three main elements of an organization, the members, tools and tasks (Argote and
Ingram, 2000, p. 153). These categories may not only be useful to describe the reservoirs of
knowledge in a firm, but also to understand the sources of knowledge.

The first factor, R&D, consists of much more research based activities. The direct
sources of knowledge in this factor are internal research and development, as well as
knowledge generated from cooperation between the firms and external universities and
research institutions. According to literature, firms that score high on this factor should have
a higher degree of absorptive capacity, resulting in a higher ability to recognize and make
use of knowledge. When reviewing the embodied factor, one important aspect is the
introduction of new technology, which substantially changes the way the main product line
is produced. This is process innovation, and the relevant knowledge is embedded in the
machinery acquisition and upgrades. In the last factor, standards, the relevant knowledge is
more codified.

The identification of different sources of knowledge implicates that the concept of
absorptive capacity has more than one dimension. This is illustrated through the
identification of the three different factors. On the other hand, there is some correlation
between the factors. This illustrates that the factors do affect each other and it could be argued that the processes discussed in the previous sections affects one other as they deal with different aspects of the same topics. It is natural to believe that different sources of knowledge demands and creates different forms of absorptive capacity. The knowledge source is important and determines the development of the firm’s absorptive capacity. One common distinctive feature of knowledge, regardless of whether it is embodied in machinery or created through research and development, is that it is cumulative. Prior knowledge permits the assimilation and exploitation of new knowledge (Cohen and Levinthal, 1990, p.136). Hence absorptive capacity is path dependent.

Table 3: Correlation between Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0000</td>
<td>0.2918</td>
<td>0.3536</td>
</tr>
<tr>
<td>2</td>
<td>0.2918</td>
<td>1.0000</td>
<td>0.3506</td>
</tr>
<tr>
<td>3</td>
<td>0.3536</td>
<td>0.3506</td>
<td>1.0000</td>
</tr>
</tbody>
</table>
### 3.4.5 Local/ Domestic Ownership

Table 4: Factor Loadings by Industry and Ownership

<table>
<thead>
<tr>
<th>Industry</th>
<th>Total</th>
<th></th>
<th></th>
<th></th>
<th>Foreign</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Domestic</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R&amp;D</td>
<td>Embodied</td>
<td>Standard</td>
<td>R&amp;D</td>
<td>Embodied</td>
<td>Standard</td>
<td>R&amp;D</td>
<td>Embodied</td>
<td>Standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Processing</td>
<td>0.07</td>
<td>0.02</td>
<td>0.15</td>
<td>0.81</td>
<td>0.35</td>
<td>0.49</td>
<td>0.04</td>
<td>0.01</td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textiles</td>
<td>-0.25</td>
<td>-0.04</td>
<td>-0.28</td>
<td>0.81</td>
<td>0.76</td>
<td>0.48</td>
<td>-0.31</td>
<td>-0.08</td>
<td>-0.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clothing</td>
<td>-0.35</td>
<td>-0.19</td>
<td>-0.51</td>
<td>-0.51*</td>
<td>-0.85*</td>
<td>-0.08*</td>
<td>-0.35</td>
<td>-0.18</td>
<td>-0.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto Parts</td>
<td>0.15</td>
<td>0.21</td>
<td>0.64</td>
<td>-0.14</td>
<td>0.27</td>
<td>0.97</td>
<td>0.26</td>
<td>0.19</td>
<td>0.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>0.33</td>
<td>0.36</td>
<td>0.73</td>
<td>0.32</td>
<td>0.49</td>
<td>0.92</td>
<td>0.35</td>
<td>0.21</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber &amp; Plastics</td>
<td>-0.18</td>
<td>-0.28</td>
<td>-0.31</td>
<td>-0.38</td>
<td>-0.83</td>
<td>0.33</td>
<td>-0.17</td>
<td>-0.24</td>
<td>-0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>-0.15</td>
<td>-0.23</td>
<td>-0.66</td>
<td>0.89*</td>
<td>0.88*</td>
<td>-0.46*</td>
<td>-0.18</td>
<td>-0.26</td>
<td>-0.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>0.35</td>
<td>0.15</td>
<td>0.09</td>
<td>0.78</td>
<td>0.54</td>
<td>0.80</td>
<td>0.25</td>
<td>0.05</td>
<td>-0.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.28</td>
<td>0.35</td>
<td>0.81</td>
<td>-0.05</td>
<td>-0.06</td>
<td>-0.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Fewer than five cases.

There are major differences in how foreign owned firms and domestic owned firms score on the presented factors. In general, over all industry fields, foreign owned firms score much higher compared to the locally owned firms on all factors. Through the R&D factors it is shown that the multinationals are more innovative and invest more in research and development. Through the embodied factor it is clear that use of technology and implementation of technology in a more creative way, result in incremental innovation in the product lines.

The differences found are continuously different. The multinationals are not only bringing new market, technology, and product knowledge, but as a result of another “base”,...
they continue to develop in another way, compared to the local firms. So is it just the prior knowledge and experience that maintain these differences? Some of the explanation could possibly also be linked to cost. It is evident that the long run cost of learning may be substantial. One incentive to conduct R&D that concerns absorptive capacity is its future contribution in the firm’s knowledge base (Cohen and Levinthal, 1889, p. 570). Even though firms accept the existence of such advantages, it may be too long term. The scope and cost perspective is not the only argument. Another aspect is the fact that all innovation processes are uncertain and comes with some degree of risk. As the product engineering rises in levels of complexity, the risk rises as well (Lall, 1992, p. 167).

### 3.4.6 Size

Table 5: Factor Loadings by Industry and Size

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>SME(^8)</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R&amp;D</td>
<td>Embodied</td>
<td>Standard</td>
</tr>
<tr>
<td>Food Processing</td>
<td>0.07</td>
<td>0.02</td>
<td>0.15</td>
</tr>
<tr>
<td>Textiles</td>
<td>-0.25</td>
<td>-0.04</td>
<td>-0.28</td>
</tr>
<tr>
<td>Clothing</td>
<td>-0.35</td>
<td>-0.19</td>
<td>-0.51</td>
</tr>
<tr>
<td>Auto Parts</td>
<td>0.15</td>
<td>0.21</td>
<td>0.64</td>
</tr>
<tr>
<td>Electronics</td>
<td>0.33</td>
<td>0.36</td>
<td>0.73</td>
</tr>
<tr>
<td>Rubber &amp; Plastics</td>
<td>-0.18</td>
<td>-0.28</td>
<td>-0.31</td>
</tr>
<tr>
<td>Wood</td>
<td>-0.15</td>
<td>-0.23</td>
<td>-0.66</td>
</tr>
<tr>
<td>Machinery</td>
<td>0.35</td>
<td>0.15</td>
<td>0.09</td>
</tr>
<tr>
<td>Total</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Firm size has an effect on the factor scores. Economics of scale are factors that make it possible for larger firms to produce more cheaply than small ones. Certain minimum efficiency scale (MES) refers to the smallest quantity where the long run average cost reaches its minimum (Salvatore 2003, p. 709). On the basis of the MES it possible to argue that firms must be of a certain size to accomplish competitiveness. It is natural to assume that the importance of size differs between industries (Gachino, 2007, p. 26). We can observe from the data that in typical scale intensive industries like auto parts, rubber and plastic and machinery, there is a large difference between the factor scores on all three factors. In electronics, which in general is more science based, the difference between large companies and small and medium is not that large. In addition, there are more obvious reasons as the large firms in general invest more in research and development. They also have a larger ability to mobilize productive resources and other internal or external services in response to external knowledge. Due to over reliance on labor intensive technologies, small firms may not make an effort to improve their technological capabilities, resulting in weak absorptive capacity as we can observe from the data (p. 28).

3.4.7 Industry

Also there are large differences within the manufacturing area of production. These affect the ease of learning, as it is dependent on the characteristics of the underlying technological and scientific knowledge the industry is built upon. It is quite obvious that the importance of absorptive capacity varies according to industry, as they differ in dynamics regarding product development. In some industries, it is more natural to use resources on process engineering (Gachino, 2007, p. 29). This is also the evidence from the data. Where

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8 Small and Medium Entreprises, less than 250 employees.
electronics score high on both factor two and three, textiles and wood score relatively high on factor one. In some industries it is relatively more important to streamline the production process, than to use resources on exploitive research and development and new product development. Some industries depend increasingly on fields based on basic science, for these industries it is important to conduct R&D to be able to identify and exploit potentially useful technological knowledge developed by universities and research institution (Cohen and Levinthal, 1989, p.593), and as illustrated in the analysis the ability to cooperate with actors that produce relative basic science.
4. Conclusion

The thesis has empirically investigated the concept of absorptive capacity at the firm level. We have identified latent structures among variables concerning technological innovation, which can be clearly related to absorptive capacity. The results do not only provide evidence on absorptive capacity at the firm level in Thailand, but also identify three different and relevant aspects of absorptive capacity. In doing so, the thesis has empirically illustrated important aspects of the concept itself.

The first factor identified is labeled R&D, which includes variables on product innovation and research stimulation from inside and outside the firm. Such a factor is an expected outcome of the analysis. It confirms that firms that engage in R&D activities and are open to external sources of knowledge, through cooperation with universities and other research institutions, are relatively advanced in innovative behavior. The capabilities captured within this factor illustrate important aspects of absorptive capacity. With reference to the theoretical understanding of absorptive capacity, this factor captures the communication between firms and the external environment. To take advantage of external knowledge, and assimilate and apply it to meet commercial ends, the theoretical concept of absorptive capacity presupposes the existence of prior, related knowledge within the firm itself. This is empirically illustrated in the first factor of the analysis.

The second factor has been labeled embodied production technology. It primarily includes the upgrade of machinery and equipment, the introduction of new technology that substantially change the way a main product is produced, and the upgrade of existing product line. The essence of this factor is that the investment in already existing technology
is linked to incremental product innovation. By combining new technology and prior related knowledge firms are in a better position to conduct incremental innovation. The first factor identified illustrated the existence and importance of an aspect of absorptive capacity in which the process of assimilating outside knowledge was related to the existing knowledge within the firm. Based on observations regarding the second factor, absorptive capacity is identified through the process of, for instance, the introduction of new machinery. In this way, new technology may contribute to incremental product innovation if this second aspect of absorptive capacity is present within the firm.

The third factor identified in the analysis has been categorized within the term standards. It mainly includes the implementation of ISO standards, but also, although less importantly, the educational level of and the firm’s formal training programs for employees. With reference to the theoretical literature, this factor captures basic aspects of absorptive capacity, through basic level process and product engineering, including quality control and assimilation of design. As compared with the two first factors, the former demand more advanced prior related knowledge than what is the case with the third, because the minimum requirements for implementing externally given standards need not include the same creativity and expertise.

In this way, there exist both advanced and less advanced aspects of absorptive capacity. The three factors have shown that absorptive capacity is not only important for producing something entirely new, as illustrated in the first factor. It is also crucial for the success that new technology and machinery brings, through incremental product innovation, as captured in the second factor. Furthermore, the third factor illustrates a more basic aspect of absorptive capacity, applicable in adjustments of already existing products and processes. However, other empirical studies of absorptive capacity using the concept only in terms of
R&D often neglect these nuances. The R&D measure is probably more useful for studies of absorptive capacity in countries that are at the technological frontier. But when reviewing a developing country, in which firms to a larger extent focus on the implementation of already existing technology, the other aspects of absorptive capacity captured in the analysis are of crucial importance.
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