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Innovation, Innovative capacities of small and large firms and Innovative diffusion

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~ Abstract ~

In this paper on innovation and diffusion the innovative capacities of small vs. large firms are discussed, reviewed and linked to the diffusion process. A commonly held view is that the relative advantages of large firms are predominantly material and those of small firms lie in behavioural characteristics. This also implies that small and large firms take over different stages of the diffusion process. However, having argued on the former we came to the conclusion that it is not solely and clearly the distinction between material and behavioural characteristics to be made. Small firms are taking over and combining the advantages of large firms and vice versa. Furthermore, we argued that when holding a dynamic view the innovative capacities regarding the diffusion process can actually overlap and the different stages in the innovation and diffusion process could occur simultaneously. Changes in e.g. communication technology and permanent changes in organizational structures of firms could lead to new innovation and diffusion processes.

Keywords: Innovative capacities, Innovation process, Innovative diffusion, Firm size

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Introduction

In order to complete the International Bachelor in Economics and Business one is ought to write a Bachelor's thesis. During my major I followed the seminars Small Business and Entrepreneurial Marketing which covered various aspects in the field of innovation, entrepreneurship, small business and marketing. I found these topics most interesting and therefore decided to write my thesis based on innovation, the innovative capacities of small and large firms and innovative diffusion.

For many decades the focus in economics was mainly on large enterprises as they were considered to be the driving force behind the economy. Nowadays the importance of small business is acknowledged in many literature at macro and micro level. At national level for example the existence of SME's (Small and Medium Enterprises) is related to the creation of jobs and at firm level SME's are considered to be a source of innovation. With changing consumer taste, growing demand for differentiation and shorter product life cycles the need for innovation is increasing. Both small and large firms are launching new products and services and are often coexisting on markets. Nevertheless, because of internal and external differences between small and large firms the innovative process is influenced as well. Many research is done on what can be seen as the battle between David and Goliath, concerning firm size and innovative capacities. As one could swiftly think that the larger firm will come out as the winner in the end, research shows that it is actually the smaller firm innovating more efficiently. Of course the innovative diffusion of the product or service in the market has to be considered as well. The purpose of this thesis will be to review the innovative capacities of small and large firms and see where they differ and/or coincide. Which innovative capacities fit best with the different stages of innovative diffusion? And how to combine them if they both come from small and large firms, which they most probably do? In addition, how could the innovation and diffusion process be influenced considering the changing environment, both producers and consumers and (communication) technology? Following are the research question and related sub-questions stated.

Research question:

- How do the innovative capacities of small vs. large firms differ and/or coincide regarding innovative diffusion, and what is the long term view on the innovation and diffusion process?

Sub-questions:

- What is innovation, how to measure this and what is innovative diffusion?

- What are the innovative capacities of small vs. large firms?

- How do the innovative capacities fit the technology S-curve and diffusion models?

- How to combine the innovative capacities of small and large firms and how does this affect the organizational structure, innovation process and diffusion?

The thesis has a theoretical approach, however, empirical data from former research can be used for clarification. The scope of the research is broad with literature and data from different countries and industries. A special note has to be made regarding the paper of B. Nooteboom (1994) on innovation and diffusion in small firms. This because it is widely discussed and compared to own idea's and findings in this paper. Chapter one gives an introduction to the topic with a definition of innovation and small and large businesses. Different types of innovation are mentioned and inputs and outputs of innovation are reviewed for a better understanding of the remaining literature.

Chapter two views the innovative capacities of small vs. large firms. Relative strengths of large firms are supposed to be predominantly material as the relative strengths of small firms mostly lie in behavioural characteristics.

In chapter three the process of innovative diffusion is described. The innovative capacities from chapter two are related to the diffusion models. Furthermore, some embryonic thoughts are given on how the combination of these innovative capacities can take different forms, again considering the diffusion models. Shifting away from conventional producer-centred innovation to user-centred innovation.

Chapter four gives conclusions of the previous chapters. The research question and sub-questions are answered and discussed.

1. Background information

1.1 Relevance

The relevance of this chapter is to provide some background information on the topic for a better understanding of the remaining literature. Different types of innovation are mentioned. Most important are the terms process vs. product innovation and incremental vs. radical innovation. Next, a paragraph is devoted to the measurement of innovations which separates inputs and outputs in the innovation process. Furthermore, some definitions of small and large businesses are given which are used in the context of this paper.

1.2 Innovation

Nowadays the term innovation is used frequently and in different contexts which makes it hard to define. To give a definition in the context of this paper we can say that innovation is the ability to apply new knowledge and/or technology to improve on existing products and/or processes. Innovation is the result of individual creativity which lies outside the scope of this paper. Thus, the organizational innovativeness of a firm depends on the sum of individual creativity within the firm.

Schumpeter's (1934) definition of innovation is "*Carrying out of new combinations*" and he gives five manners to do so: The introduction of a new good; the introduction of a new method of production; opening a new market; opening a new source of supply and carrying out of a new organization in an industry. From the first and second manner we can distinguish product and process innovation. Product innovation can be an improvement in existing products or the creation of a "new" product by combining inventions. This innovation finds its use outside the firm. On the other hand, process innovation can be an improvement in the production process or a creation of a new production process. This innovation finds its use within the firm; hence the producer of the innovation is also the user.

Furthermore, a distinction can be made between incremental innovations and radical innovations. Incremental innovations are minor improvements in existing products or processes and are seen as evolutionary.

Radical innovations are new products or processes and are seen as revolutionary. Nevertheless, there are many degrees of innovation in between and the newness of the innovation is open to subjectivity.

1.3 Measuring innovation

Having defined the term innovation shortly, we will now have a look at how to measure this within a firm. The most traditional way of measuring innovation within a firm has been the rate of R&D. Booz, Allen and Hamilton (2007) did research on the effect of R&D spending on sales growth, earnings and shareholder returns. They found no relationship between R&D spending and the forenamed outcomes. Furthermore, one dollar spent on R&D is equal to its cost. R&D can be considered a fairly risky process, yet when one succeeds it can be very profitable.

Nevertheless, these results should be not surprising as R&D spending is an input instead of an output of innovativeness. What are then correct measures of innovativeness? And are sales growth, earnings and shareholder returns outputs of innovativeness? At first this seems a reasonable assumption. Firms that innovate at high speed usually outperform firms that lag behind in innovativeness. However, the correlation between these factors as measures can be biased. Sales growth and earnings can come from other factors as well. The firm with high sales growth and high earnings might have done a great job at copying some other firms innovativeness and may not be very innovative itself (Acs, Z. J., and Audretsch, D. B., 2005)

Next to the input R&D Acs and Audretsch (2005) describe two other measurement methods of innovation. The first is measurement by patents which can be seen as an intermediate output. There is a clear relation between a firm's innovativeness and the number of patents it owns. Still, patents do have some drawbacks as well. First, many patents are considered to be useless or "sleeping" patents. There are many patents for inventions that never will have any use for consumers or other markets. Thus, the quantity of patents says nothing about the quality of the innovations. Second, not all inventions are patented some inventors choose to rely on secrecy instead of patenting (Acs Z. and Audretsch D.,2005; Hall B.H., Jaffe A. and Trajtenberg M., 2005).

The third way described is by the direct measurement of innovative output and was not done before the 1970s. Mentioned are several data bases providing a direct measurement of innovation with the most recent and major one the U.S. Small Business Administration’s Innovation Data Base (SBIDB). Acs and Audretsch used these databases to measure the relationship between firm size and technological change and market structure and technological change. The results were generally similar concerning small and large firms and showed that small firms on average introduce over two times more innovations per employee than large firms.

Nevertheless, just as with the conventional measurement methods the direct method has some drawbacks as well. One of the main limitations for these measurement methods is the implicit assumption of the homogeneity of units (Acs Z. and Audretsch D., 2005). This means that the different innovative output measured is considered to have equal value and the market value generated by this innovation, R&D and patents is assumed to be homogeneous. Of course this does not represent the reality. However, new methods are being implemented as measuring the proportion of sales generated by products introduced within the last couple of years to get a better approximation of the market value by innovation (Acs Z. and Audretsch D., 2005).

1.4 Defining small and large businesses

Defining firms by size is a hard task and can be done in different contexts. According to the European Commission small and medium sized enterprises are classified and separated from large enterprises by headcount, turnover and balance sheet total. The associated figures are depicted in the table below.

Table 1.

Enterprise category	Headcount	Turnover	or	Balance sheet Total
medium-sized	< 250	≤ € 50 million		≤ € 43 million
small	< 50	≤ € 10 million		≤ € 10 million
micro	< 10	≤ € 2 million		≤ € 2 million

Source: ec.europe.eu

Nevertheless, since not all small firms are innovative and this paper has a theoretical approach a different definition is considered more appropriate.

Till recent times large firms were considered to be the driving force behind economic growth. When technology and knowledge became more important the importance of small firms and innovation was recognized as well. Several theories describe the relationship between firm size and innovation; two different visions are given by Schumpeter (1909; 1942). The first one describes the process of “creative destruction” in which it is the small firm being the driving force behind change and innovation. In the second vision on the contrary it is the large firm which has the market power and resources to be the most effective innovator.

In their paper on Innovation, Entrepreneurship and Technological change Acs. and Audretsch (2005) conclude that recent studies show that both small and large firms are contributing to innovative output. Were it was first only the large incumbent firm holding an advantage, new measurement techniques made it possible to recognize the importance of small firms concerning innovation. A second view is that this importance did not emerge because of new measurement methods yet because the economic and social environment changed in a favourable direction for the innovative advantages of the small firm.

In the context of this paper and its basic form the term `small firm` denotes a firm (with on average 50 employees) driven by change, flexibility and innovative activity. The term `large firm` refers to a firm (with on average more than 250 employees) characterized by stability, scale production and as well the ability to innovate.

2. Innovative capacities of small vs. large firms

2.1 Relevance

The relevance of this chapter is to describe and compare innovative capacities of small and large firms after which they are suited to the diffusion process and elaborated on in the next chapter. This is done on firm and individual level which is found most appropriate in this paper. Large firms are considered to have more market power, easier access to capital, better access to R&D and are able to spread risks over their diversified portfolio. Small firms are supposed to be risk-taking, more eager to innovate and flexible due to a lesser degree of bureaucracy and hierarchy. The following paragraphs elaborate on these capacities.

2.2 Competition and innovation

Regarding market entry and competition one could make the logical assumption that it is the small firm facing this competition more severe as other firms are already well established in the market. Nevertheless this small new firm is bringing new competition into the market as well. A commonly held view is that firms invest more in R&D and stimulate technological progress in more competitive markets where the entry pressure is higher. Because of their monopoly power and no entry pressure large firms are assumed to innovate less than their smaller followers. The former coincides with the findings of Arrow(1962) which show that large firms have less motivation to invest in R&D than small firms. Furthermore, in the case of a free open market with competition, large firms will not invest in innovation at all leaving this matter to the new smaller firms.

On the contrary, it is the bigger established firm which not only has the capacities to innovate but actually does so. Research shows that *“market leaders do invest in R&D more than other firms when they are under the competitive pressure of endogenous entrants. The immediate consequence is that under these conditions incumbents are more likely to innovate and therefore to persist in their leading position”* (Czarnitzki D., Etro F. and Kraft K., 2008, pp 24.).

Thus, the motivation of new smaller firms to innovate is to get a good grip in the market and that of the bigger already established firms is to persist in their leading position and not to lose their market share.

2.3 Economies of scale

Associated with large enterprises are economies of scale and scope. Regarding innovation this is a characteristic which is always been considered favourable for the large firm. First, once an innovation is turned or implemented into a product economies of scale allow large firms to produce large amounts against low costs. Second, next to economies of scale in production there can be as well economies of scope in R&D. Large firms hold economies of scope in the promotion and distribution of (new) products which enables them for greater profits from innovation (Scherer, 1991). Third, in case of an innovation leading to cost reductions within the firm there will be higher profit margins for larger than for smaller firms due to scale economies.

Technological developments especially in information and communication sectors have seem to diminished transaction costs and minimum efficient scales which is beneficial for smaller firms. Yet, when new technologies mature economies of scale can eventually take over again (A. Thurik, L. Uhlaner and S. Wennekers, 2002). Still, we have to keep in mind that this is not a certainty in this case.

Nevertheless, next to the arguments in favour of the large firms there can be a technological trade off between *efficiency* and *flexibility* (David Mills, 1984). Large firms which are mostly capital intensive can produce a certain amount of output at lower costs than small firms at a point in time. Small firms on the other hand which are mostly labour intensive can produce at lower marginal “adjustment” costs over time when demand fluctuates.

2.4 Absorptive capacity

Absorptive capacity is an important factor considering a firm’s innovative capacities. Absorptive capacity is a firm’s ability to recognize, assess and apply new knowledge, this can be described both at individual and firm level. The theory was first introduced by Cohen and Levinthal(1990) which find it a reason to invest in R&D as this generates innovation and facilitates learning.

A difficulty in this theory has been, and still is, that absorptive capacity is intangible and mostly developed as a by-product of a firm's activities.

Further studies and refinements on the theory and models of absorptive capacity have led to the term "dynamic capability" which is defined as *"the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments"* (Teece, D., G. Pisano and Shuen, A., 1997, pp.509-533).

In most economic literature it is considered that large firms have an advantage in absorptive capacity over small firms. Large firms have better access to and conduct more R&D which helps to create absorptive capacity. Furthermore, in addition to the problem of fewer functional specialists in smaller firms, which depends on education and experience, is the problem of tacit knowledge as described by B. Nooteboom (1994). Tacit knowledge is knowledge acquired in learning by doing instead of learning by teaching and can be therefore locked in without the possibility of understanding and structural application of it. Large firms tend to have less tacit and more explicit knowledge due to their organizational structure.

The factor R&D mentioned relates to the firm level and tacit knowledge relates to the individual level which on its turn is influenced by the firm. The traditional view is that firms exist exogenously and make knowledge investments to generate innovative output. Nevertheless, this view can be reversed which makes the individuals and their knowledge exogenous and the firm endogenous depending on the worker's effort to apply the knowledge by way of innovative activity (D. Audretsch and R. Thurik, 2004). Thus, despite that large firms seem to have better absorptive capacities small firms can compensate for this by spill-over's and spin-off's which are addressed next.

2.5 Geographic proximity

Geographic proximity is as well an important term to discuss in the context of innovative capacities of small and large firms. For large firms the geographic environment serves as a mean to combine their production factors capital and labour. Smaller firms which are highly dependent on knowledge and choose their geographic location in the context of innovative clusters and spill-over's.

Knowledge spill-over can be seen as a glass(the firm) being filled with too much substance(knowledge), when another glass is located close enough it can catch the spilled substance. There are several reasons why geographic proximity is more important for small firms and generates valuable knowledge spill-over's. First, at firm level large firms are vertically integrated and especially compete in product markets. Corporation and competition can be therefore seen as substitutes. Smaller firms are vertically independent meaning that communication with other firms is of great importance and competition and corporation are complementary. Second, at individual level there is a difference between a homogeneous and heterogeneous population in a firm. In a heterogeneous population the information individuals posses is more diverse and can contribute more likely to innovative idea's than in homogeneous populations. The transaction costs of information are higher for smaller firms with a heterogeneous population, however, they are compensated for by knowledge spill-over's resulting from interaction (D. Audretsch and R. Thurik, 2004).

Another phenomenon which compensates small firms for their lack of R&D hence, their lack in absorptive capacity, are spin-off's. A spin-off in its basic sense and in the context of this paper can be seen as a carrousel(the firm) spinning around and loosing one of its seats(individual/employee). Usually an employee, often a scientist or engineer, working in the research laboratories of a large firm will have an innovative idea. The employee wants to be compensated accordingly for this potential innovation. Nevertheless, the firm may have a different view or valuation of this potential innovation. When there exist a large divergence in expected return from the innovation between the employee and the firm, and if the opportunity costs of entrepreneurship is low, the employee may decide to leave the large firm.

The new smaller firm is considered to be a spin-off from the large firm and is exploiting the experience and knowledge from the R&D of the large firm (Acs Z. and Audretsch D., 2005). This gap between the individual and the firm can be addressed to deficiency's in innovative capacities of firms which are discussed in the next section.

2.6 (D)efficiency's in innovation

The degree of efficiency in innovation has been examined in many industries. Still, there is a shortcoming on data to determine whether it is the smaller or larger firm innovating more efficiently. Some firms have the innovative capacities but do not use them efficient enough due to e.g. their organizational structure. In their paper on the value of entrepreneurship C. van Praag and P. Versloot (2007) have combined and compared empirical results on this matter. The conclusions in basic lines are that small firms do not spend more on R&D than large firms. They realize less patents, new products, and radical innovations but do so with a greater efficiency and quality when considering the number of patent citations. Furthermore, small firms score high on the commercialization of innovation but low on the adoption compared to large firms. One explanation for more innovations in larger firms could be a wider range of products to improve on. On the contrary, measuring innovations per employee shows that smaller firms are more efficient than their counterparts (J. Love and B. Ashcroft, 1999).

Other economic theories describe a technological paradigm in which an innovation is developed. Large firms are supposed to work within the core competencies of the firm resulting in incremental innovation. By contrast, small firms with the ability to be flexible want to break out of the technological lock-in which should result in more radical innovations (D. Audretsch and R. Thurik, 2004).

There are several reasons at firm level and individual level why large firms with innovative capacities do not always do so successfully. One reason preventing to innovate efficiently and described by Hofstede (2001) is power distance. Power distance in a firm can be seen as the relationship between employer and employee.

As already mentioned before an employee can have an innovative idea or valuable comment on the business process. When the power distance and inequality between employer and employee is high enough the valuable information or innovation can be lost.

Another reason is individualism and describes the degree to which people see their work within an organization as separated from the whole (Hofstede, 2001). To unlock the innovative capacities of individuals they should be challenged in their job and left with sufficient time and freedom to find their own approach in their work. This might also explain why employees gain more utility from working at smaller firms even when compensated less. The former can be backed up by Scherer (1991) who says that the smaller firms place innovative activity at the core of their business strategy and where the excitement is higher because *“the links between challenges, staff, and potential rewards are tight”* (Scherer, F. M., 1988, pp. 83.)

2.7 Financial resources

The fact that large firms have more capital and financial resources than small firms is straightforward. Large firms have large turnovers and in some cases realize “monopoly” profits. Financial resources in small firms are not only necessary in the start up process but also later on to invest in R&D.

Large firms are able to obtain capital more easily as well externally as internally. The ability to finance R&D internally can be important in the sense that you do not have to disclose any information about the project (R. Vossen, 1998). On the other hand, external financing in large firms can be easy yet puts more constraints on profits since most large investors want security.

Small firms obtain their external capital mostly from banks or private resources like friends or family. This allows for variance in claims on profits as banks only claim repayments of debts and private resources have mostly low demands on profits (B. Nootboom, 1994). Variance in demand on profits allow small firms to take more risks and in some situations even to sustain losses for a period of time.

2.8 Advantages summarized

- Large firms have market power and conduct more R&D; Small firms use local proximity to compensate by spin-off's and spill-over's due to vertically independence.
- Large firms have easier access to capital and are able to spread risks; Small firms have more variance in claims on profits which allows them to take more risks.
- Large firms exhibit economies of scale in production and economies of scope in R&D; Small firms have an advantage in "adjustment" cost when demand fluctuates.
- Large firms have a high degree of bureaucracy and hierarchy which enables for explicit knowledge and career opportunities; Small firms have a lesser degree of bureaucracy and hierarchy which enables for flexibility and faster innovations.
- Large firms have explicit knowledge and better capacities in absorption; Small firms have tacit knowledge which protects the innovation and appropriates rewards.
- Large firms have an advantage in the production and distribution process in large markets; Small firms stand closer to customers in niche markets with the capacity for customization.
- Large firms have more functional specialists with better management skills and assessment of innovations; Small firms have an intertwined staff which is more motivated and efficient in innovative activities.

3. Dynamics of innovation and diffusion

3.1 Relevance

First, the diffusion of a product or service in the market is described which typically is represented by an S-curve. Second, the innovative capacities from the previous chapter are reviewed, elaborated on and linked to this diffusion models. This will show where the innovative capacities of small and large firms differ and/or coincide regarding the diffusion process. Possible combinations of these different capacities and firms are discussed. Furthermore, a model from innovation till the diffusion in the market is given with a different view on the innovative diffusion process compared to conventional ones. Finally, an example of a new innovation process and organization is discussed.

3.2 Diffusion models

Diffusion models represent the diffusion of a product or service among a population. The appropriateness and speed of diffusion depends on several factors which are mainly embodied in the following elements: The innovation; Communication channels; Time and Social system. The innovation process starting at the firm goes through communication channels (internal and external) and over time after which it reaches the individual in the social system. The innovation process is mostly characterized by the following steps:

- > The invention to innovate with.
- > The development of the innovation.
- > The implementation and production of the innovation.
- > The introduction of the innovation/product into the market.
- > The diffusion of the product or service.

Once the product or service can be diffused into the market by the firm it still has to go through the process of adoption by the users. The adoption process consist out of several stages as well and is here described as by E.M. Rogers, for the first time in 1963¹. The adoption process is characterized by the following stages:

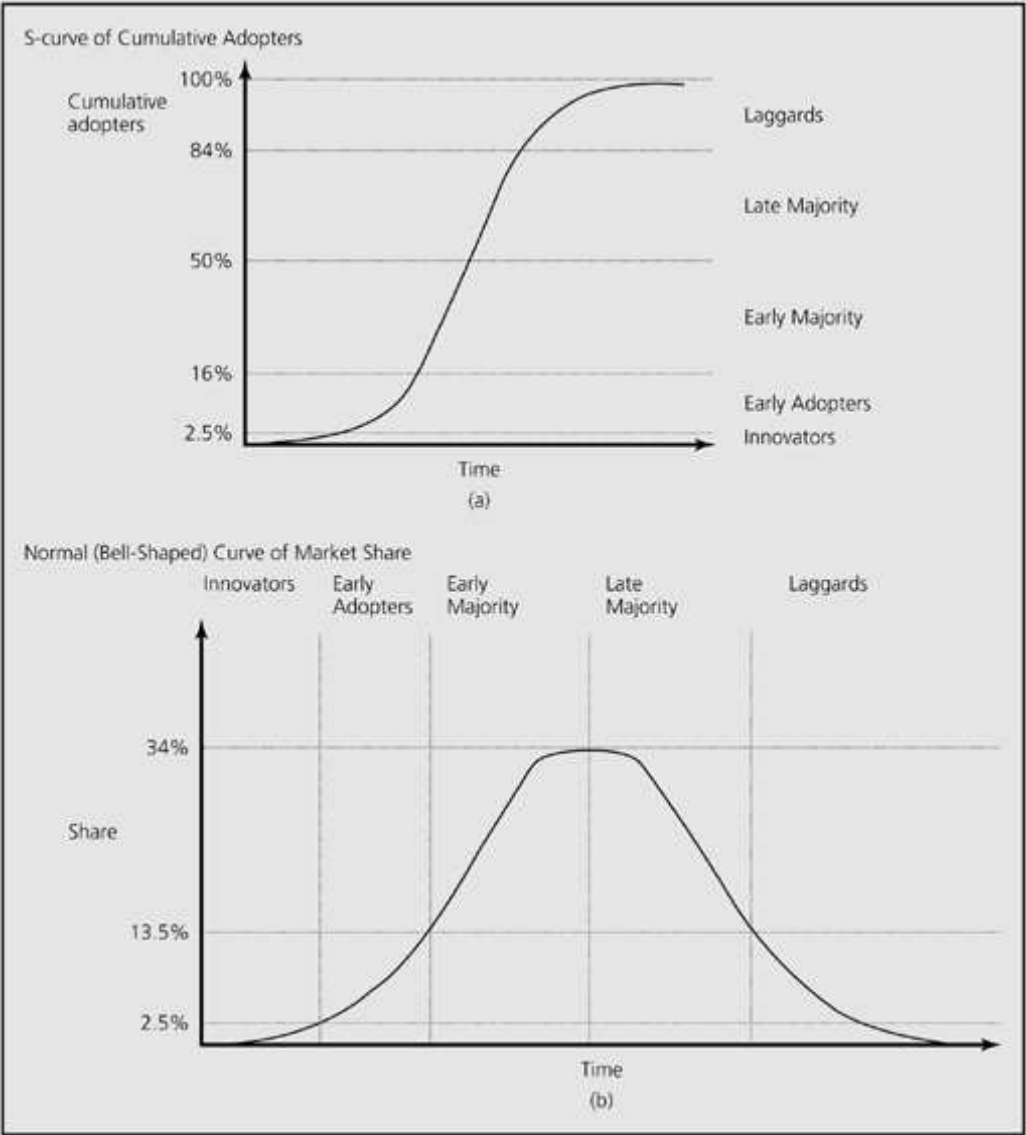
- > Knowledge, which is the first notion of an individual or entity about the existence and basic understanding of the innovation.
- > Persuasion, which results in the position an individual or entity takes regarding the innovation. This can be positive or negative.
- > Decision, which is the active involvement of the individual or entity that leads to adopting or rejecting the innovation.
- > Implementation, which is the use of the innovation by an individual or entity.
- > Confirmation, which leads to a definite usage of the innovation or still to the rejection of the innovation due to e.g. dissatisfaction.

The speed of the adoption process depends on the individuals and can be described by the adopter categories as proposed by E.M. Rogers (1983). The individuals which adopt the innovation first are “innovators”. According to Rogers the first 2,5 percent of the population belongs to this category.

¹ <http://docjourney.wordpress.com>

They are characterized by a high degree of complexity and uncertainty. Belonging to the second category and accounting for 13,5 percent of the population are the “early adopters”. They are seen and respected as opinion leaders. The following category accounting for 34 percent of the population is the “early majority”. They are no opinion leaders, yet they adopt the innovation before the average individual. Accounting for another 34 percent is the “late majority” which is more skeptic about the innovation. The last 16 percent of the population consists of “laggards” which may have no opinion leader and need a high degree of affirmation about the innovation before adopting at all. The bell shaped curve of adopter categories is showed in figure 1.

Figure 1.



Source: Reader: Introduction to the Economics of EGOS 2009

There are many models to use regarding the diffusion of products. A.F. Baudisch and H. Grupp (2006) have compared several diffusion models and came to the general conclusion that it takes time for an innovation to diffuse in to the market and that this diffusion can be represented by an S-shaped curve. First, the adoption is slow because the innovation is yet not well known, after which the adoption accelerates when the innovation is understood and utilized by the mass market. Finally, the rate of adoption stabilizes when the market saturates. The S-shaped curve related to the cumulative of adopter categories is showed in figure 1 as well.

3.3 Innovative capacities and diffusion

When looking at the innovative capacities of small and large firms regarding the diffusion models we should first start with the invention to innovate with. Many studies show that the strengths of large firms are predominantly based on material resources and that of small firms lie in behavioural characteristics (Rothwell and Dodgson, 1994; Nooteboom, 1994). This means that large firms will generate more new radical innovations due to their capacities in R&D laboratories and specialized teams. The small firm will be better in the implementation of the innovation because they are more flexible and closer to the market. Hence the small firm is better in generating incremental innovations.

On the other hand, there are findings that it is the small firm which has to innovate earlier in the product life cycle with a more radical approach (Audretsch, D. and Thurik, A., 2004). The large firm is bounded to the core competencies and technological paradigm of the business generating incremental innovations. As mentioned before the small firm wants to innovate outside the technological lock-in which results in a more radical innovation. Thus, regarding these findings we can say that it could be both the small or large firm coming up with a new invention to innovate on. Most probably this will depend on the specific industry and circumstances of the large or small firm.

Because of this antinomy we could also argue about some other relative strengths and weaknesses in innovation of small and large firms given in chapter 2.

Considering the literature regarding economies of scale it is the larger firm which should have an advantage.

This would be an advantage in approximately the middle of the S-curve with the production of the innovation. Large firm can produce large amounts against low costs. Nevertheless, regarding production and sales from innovations established by universities, it is the smaller firm generating higher royalty revenues (R. Lowe and A. Ziedonis, 2006). We could partly explain this by the fact that small firms can achieve higher profit margins especially when operating in niche markets. On the other hand, large firms mostly operate in mass markets with mass productions and lower profit margins. Thus, contrary to the previous mentioned the economies of scale could turn out to be “diseconomies of scale” when regarding the profits from innovations.

Yet, having said the former one should take in to account that it is not solely the small firm operating in niche markets nor the large firm solely operating in mass markets. A large yacht manufacturer can operate in a niche market delivering customized products, yet it qualifies as a large firm. This also influences the view on competition and innovation as described in chapter 2. When small and large firms operate in different markets there is no entry pressure from each other and no pressure to innovate. Nevertheless, fact is that small and large firms actually do operate in the same markets and the distribution regarding firm size and size of the market is mixed depending on the industry. In addition, nowadays the need to innovate does not heavily depend on entry pressure anymore. Lacking to innovate means getting behind in a rapid changing environment with changing consumer tastes and needs.

Regarding the final diffusion of the product in to the market it should be the large firm having an advantage due to their economies of scope in the promotion and distribution of new products. Again on the other hand, the small firm has a closer proximity to the customer which enables for closer contacts and relationships. Here we can assume that both small and large firms could have an advantage depending on the consumer or entity and its knowledge about the innovation.

Thus, the “early majority” could be reached as good by small firms as by large firms. Yet, the “late majority” would be reached sooner by the large firm which can make use of the brand name and promotional activities.

Thus, the innovative capacities of small and large firms regarding diffusion can turn out to be favourable or unfavourable depending on the stage of diffusion and the specific circumstances. Despite the fact that large firms will always have some advantage over production factors considering the mass market, it is not solely the distinction between material resources and behavioural characteristics to be made. In addition, contrary to the view that small and large firms take over different parts of the diffusion process one could say that at some stages of diffusion they actually overlap.

This view can be explained, as mentioned before, by the fact that some factors influencing the innovative capacities and actions of the firm as described in chapter 2 are open for change. Take for example the geographic proximity and its reasons behind the importance for small and large firms. The importance for small firms should be higher because they are vertically independent and large firms are vertically integrated. Yet, when looking at some industries e.g. the automobile industry the same technology, for example engine, is used for different car brands operating as independent firms.

In addition, it is noticeable that large firms are acquiring or merging with other large firms and not merely with small firms. This means that large firms do not always have to compete on the innovation but rather on the brand they hold. Contrary to the literature description given in chapter 2 where competition and corporation are complementary for small firms and substitutes for large firms, the former implies that competition and corporation to some extent are complementary for large firms as well.

3.4 Combining innovative capacities

In the previous paragraph we came to the conclusion that the innovative capacities of small and large firms regarding diffusion can actually overlap, and that a clear distinction can not always be formed regarding relative advantages and diffusion.

With this statement we imply that the relative strengths and weaknesses as described in the previous chapter are subject to change as we just argued.

The reason for deviation from conventional theories and literature as described in this paper is “change” itself.

As theoretical papers are being written about the innovative capacities of firms regarding size and empirical research is conducted, firms themselves do not stand still either. Large firms have noticed the advantages of smallness in the innovation process and vice versa.

In his paper on the open innovation paradigm Rasmussen (2007) writes how alliances are able to create additional value for the firm. The evolution of this paradigm shows that the innovation process has developed from one conventionally held by large firms to one where small and large firms are equally important and interact. This distribution of labour and capital has created a possible exchange between the producers and users of a technology. This also means that the innovation should be easy to use and does not have to cope with the problem of tacit knowledge as described in the previous chapter. Arora, Fosfuri and Gamberdella (2001) have noticed several changes in this exchange of technology and state that in general the transferability can be enhanced when the innovation is separated into independent tasks.

Vossen (1998) as well describes the complementary roles of small and large firms in innovating and gives an example of a large firm which has successfully done so. The firm 3M operates on three levels concerning their R&D process and does this independently on each level. Yet, cooperation between each level is crucial. The specific product on each level belongs to the division still the innovation belongs to the company. We can notice that a large firm is able to establish separate divisions within the company to benefit from the advantages created by smallness. This is just one example on how the relative advantages of small and large firms can be combined. However, when such combinations of innovative capacities are becoming realisable the diffusion process is affected as well.

Of course it is not only the large firm taking over some forms of small firms in their organization. By means of a natural way the small firm grows bigger and additional layers in the company arise. During this process some relative advantages of smallness erode and other mostly scale advantages evolve.

As Nootboom (1994) describes, when small firms become more like large firms and vice versa what is then left from the view of complementarities. He continues with the statement that in many aspects large firms will stay large and the same holds for small firms. However, when taking a dynamic view on the change in the organizational structures of small and large firms one could make the assumption that new permanent firm structures can evolve, meaning a change in the diffusion process as well.

3.5 Dynamic innovation: user-centred innovation

Conventionally the innovation process is assumed to take place successively from the invention to innovate with to the diffusion of the product. According to Nootboom (1994) it is riskier for small firms to realize the first three stages of the innovation process especially when concerning radical innovations. This because there exists no market yet and the stress lies on “push” strategies involving marketing in which small firms perform poorly. Nootboom (1994) says that one of the few if not only chances for small firms is to develop radical innovations in interaction with innovative potential users as described for the first time by von Hippel (1988).

Such strategies will affect the innovation process and the invention, development, implementation and production of the innovation occur simultaneously. Small firms should have an opportunity here because of their size, flexibility and proximity to the consumers.

However, what if we consider a large firm following such practices with the ability to perform well in the last two stages of the innovation process as well. This results in all the five steps of the innovation process occurring more or less simultaneously with a higher certainty of success. Currently these strategies are becoming reality and firms shift away from producer centred innovation to what is called user centred innovation. The main difference is that with user centred innovation users themselves innovate to fulfil their specific needs.

Where usually the firm identifies customer's needs, invests large sums in R&D and profits by commercializing, now *"lead users innovate to solve their own needs at private expense and then freely reveal their innovations."* (Christopher Lettl, Aarhus School of Business, Denmark)².

Reasons why this process is emerging are advances in information and communication technologies and lower transaction costs, think of e.g. instant messaging systems, podcasting and blogging. Motives for consumers to innovate are higher expected benefits from the innovation compared to the producers (von Hippel, E., 1988; Lüthje, C. et al, 2003). Furthermore, the costs of innovation for users are lower compared to the R&D costs of producers (von Hippel, E., 2007). Empirical research shows that innovating consumers mostly qualify as lead user which puts them in the first adopter category, the innovators, of figure 1. Some studies illustrate that lead user based innovations produce eight times higher sales compared to innovations generated in-house³.

What we should consider in this new approach to innovation is product vs. process innovation. Nootboom (1994) says that regarding the diffusion process we should make a distinction between process and product innovation. Small firms are supposed to perform better in process innovation and large firms in product innovation. Furthermore, Nootboom (1994) gives the term "dynamic complementarity" in which small and large firms take over different stages of the diffusion process which is backed up by empirical evidence. As stated before it could be possible that small and large firms are beginning to overlap in these stages of diffusion and so do the terms product and process innovation. First, a process innovation can help to speed up the firm's competencies to develop a product innovation. The other way around, a product innovation may contribute to the evolvement of a new process leading to process innovation. Finally, what is a product innovation for one firm may at the same time be a process innovation for another firm.

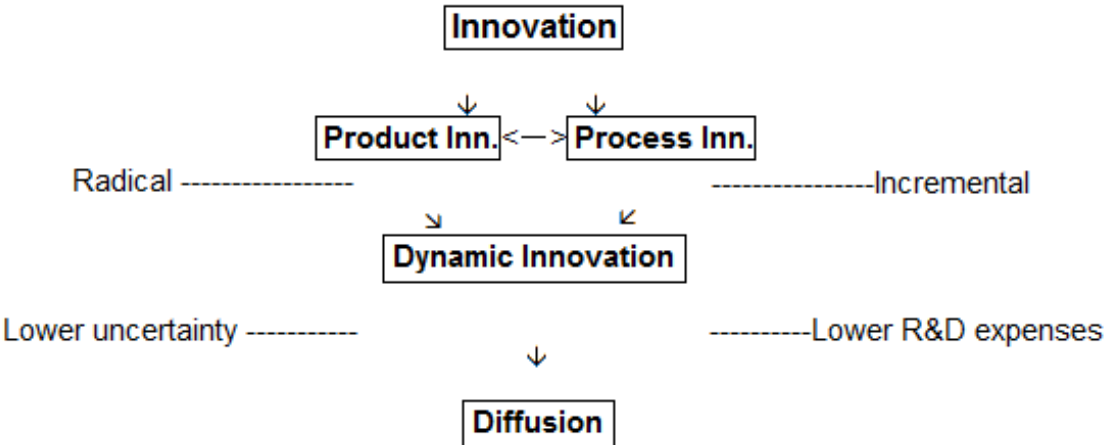
² http://www.sics.se/utsikt07/User_centered_innovation_LETTL_STOCKHOLM_FINAL.pdf

³ Lilien, L. G. et al., 2002, "Performance Assessment of the Lead User idea-generation process for New Product Development", Management Science, Vol.48, No.8, pp. 1042-1059

With new innovation processes as user centred innovation one could imply that process and product innovation occur simultaneously, see figure 2. In such a process the innovator is not only the user of the innovation regarding process innovation, yet also the user of the product regarding product innovation. In addition, departing from this point of the process the innovation could be incremental as well as radical because of less uncertainty in the diffusion of the product making radical innovations less risky. This uncertainty is reduced because of the fact that the end user is involved in the innovation process. Therefore, as mentioned before several if not all stages of the innovation process can occur at once depending on the industry and organizational structure of the firm. This is called dynamic innovation in figure 2.

In addition, this process not only leads to lower uncertainty and R&D expenses considering innovation, yet also the adoption process can be simplified. The persuasion, decision, implementation and confirmation of the product becomes more straightforward given that a lead user is the innovator in the production process. It does not imply a certain quick adoption by all, however, it does increase the chance of adoption. Following in the next paragraph is a practical example of such an innovation process.

Figure 2.



3.6 Practical example of user-centred innovation

The Danish User-Centred Innovation Lab (DUCI lab) is a unique initiative by the Danish government to analyse matters regarding user-innovation processes. This is a cooperation between the Copenhagen Business School (CBS), Aarhus School of Business and Massachusetts Institute of Technology (MIT) and is founded in Copenhagen, Denmark. A number of academics, the Danish government and six major Danish companies (Lego, Novo Nordisk, Danisco, Bang & Olufsen, Coloplast and IO Interactive) are collaborating to identify the best practices concerning user centred innovation among leading firms. They explore how these advanced practices can be diffused broadly for the benefit of small, medium sized and large firms⁴. To set up a national user-centred innovation program several measures should be implemented⁵:

- Some professorships with leading specialists should be staffed.
- A program to finance research and diffusion efforts should be implemented.
- Professors and firms need to establish a collaborating laboratory to test, develop and diffuse best practices.
- A national innovation policy needs to be adopted to support user centred innovation e.g. by the promotion of users' rights to develop and modify standard products.

Illustrating the importance of the Danish user-centred innovation lab is the example of LEGO. Lego is a successful Danish company constantly trying to improve on its user-centred designs to develop new products, increase sales and stimulate growth. It became famous with the development of Lego bricks, a toolbox system in which coloured plastic bricks, cogwheels and figures could be clicked together to build all different kind of models. In 2004 Lego decided to establish a "Mindstorm" user panel to request feedback on a new product which combined original Lego products and computer controlled robotics. The company identified five lead-users from the Mindstorm community who actively led the development of new applications for the product. These five users were recruited via e-mail to assist Lego with a special mission, namely to develop the next generation of the core product.

⁴ <http://www.duci.dk/>

⁵ http://www.tietoyhteiskuntaohjelma.fi/ajankohtaista/events/en_GB/1147340579176/_files/76290664743699224/default/Lettl_201106.pdf

The Mindstorm user panel held phone conferences, met virtually on a secure website and for sessions in Denmark and Washington. This to develop a computer brain within Lego bricks featured by three stepper motors and light, touch and temperature sensors⁶. By allowing adult fans of Lego to participate in the product development teams they could launch the next Mindstorm robot product line successfully and strengthen linkages between young fans that want to share their ideas online. The entire product development process was effectively based on user-centred innovation designs allowing Lego to increase sales and gain market share⁷.

4. Conclusions and discussion

4.1 Relevance

The relevance of this last chapter is to review the previous chapters giving a conclusion of each of them. Next, the sub-questions and main research questions are answered and discussed.

4.2 Conclusions

In chapter one the term innovation was defined as the ability to apply new knowledge and/or technology to improve on existing products and/or processes. We said that the organizational innovativeness of a firm depends on the sum of individual creativity within the firm. A distinction was made between process vs. product and incremental vs. radical innovation. Furthermore, different types of measurement methods were described and compared which resulted in the conclusion that the pure innovativeness of a firm is hard to measure and the best way to do so is by direct measurement methods. In addition, small and large businesses were defined as found most appropriate regarding this paper.

Chapter two described the relative advantages of small and large firms as given by most of the literature on this topic. The relative advantages were sorted under headlines which are found most important considering innovative capacities and which are supposed to cover the most important advantages.

⁶ http://www.innovaro.com/inno_updates/Innovation%20Briefing%2009-06.pdf

⁷ http://www.tietoyhteiskuntaohjelma.fi/ajankohtaista/events/en_GB/1147340579176/_files/76290664743699224/default/Lettl_201106.pdf

Several contradictions were found in the literature on the innovative capacities of small and large firms. Considering competition and innovation it can be as well the small and large firm which has to and does innovate under entry pressure.

Economies of scale though are still found most beneficial for large firms, yet there exist a trade of between efficiency and flexibility. Regarding absorptive capacities it is the large firm holding an advantage having more explicit knowledge compared to the tacit knowledge within small firms. Large firms are described by most literature as vertically integrated which means that competition and corporation are substitutes. On the other hand small firms are vertically independent and can benefit from spin-off's and spill-over's. Furthermore, research shows that small and large firms score better at different stages considering innovative efficiency. Although some of the literature contradicts, in main lines the relative advantages of large firms are still mostly described as material and the relative advantages of small firms as behavioural.

In chapter three we described the innovation and diffusion process which is mostly represented by an S-shaped curve. The relative advantages from chapter two were discussed critically which also influenced the innovation and diffusion process.

Several antinomies were found in the relative advantages. We argued that both small and large firms can operate in niche and mass markets and both small and large firms can hold (dis)economies of scale. In addition, we argued that large firms can turn out to be vertically independent with the terms competition and corporation as complements. Holding this view a clear and solely distinction between material and behavioural characteristics could not be made contrary to conventional theories. Small and large firms can overlap in their innovative capacities and so can they regarding the diffusion process. Were other literature argues that small and large firms take over different parts of the diffusion process we argue that they can actually overlap in this diffusion process. The former comes from holding a dynamic view on change in the organizational structures of firms. New innovation processes and organizational structures along with a changing environment and (information) technology are enabling firms to get the best out of being a small and large firm. Finally, an example of user-centred innovation was given in chapter three.

4.3 Research questions and discussion

With the former given conclusions some sub-questions are answered already partially. The most basic sub-questions as “What is innovation, how to measure this and what is innovative diffusion?” were answered and discussed. The main research question remains “How do the innovative capacities of small vs. large firms differ and/or coincide regarding innovative diffusion, and what is the long term view on the innovation and diffusion process?”

Regarding the findings in existing literature it can be said that many of the relative advantages in innovative capacities of small and large firms both coincide and contradict. As strengths of large firms are supposed to lie predominantly in material resources and that of small firms in behavioural characteristics, the small and large firms are also supposed to take over the different parts in the diffusion process. However, having reviewed and critically discussed the innovative capacities of small and large firms we came to the conclusion that due to permanent changing organizational structures the innovative capacities of small and large firms are neither solely material nor behavioural. Small and large firms are combining their advantages and collaborating which results in extra added value. This can happen in such new manners that the conventional innovation and diffusion processes are subject to change as well. Both the innovation and diffusion process can be simplified and several if not all stages could occur simultaneously.

We see that the organizational structures and innovative processes of firms are changing yet empirical evidence is missing to have insight in which pace and on what scale this is or could be occurring. One could say that it is the question: what is the perfect size of a firm to operate most efficiently (as well considering innovation) that should be answered. However, e.g. economies of scale are necessary at some point given a large market and the answer can be therefore better looked for in the organizational structures of different firms.

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