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The Economic Benefits of Participating in European Space Agency Programs

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Abstract

The European Space Agency and Norwegian Space Center state that one major aim of their space programs is to generate industrial growth in the form of synergies, spinoffs and spillovers. This thesis investigates whether these two institutions achieve this goal by studying the economic benefits Norwegian companies derive from participating in European Space Agency programs. Innovation theories are used as a theoretical framework and three possible ways ESA contracts generate economic growth are explored, with focus on capabilities as an important concept. Rosenberg`s theories of technology transfer, Teece, Pisano and Shuen`s theories of capability development, and Henderson & Cockburn`s theories of spillover are used throughout the work as important references.

The thesis employs a case study design, where it compares the experience five Norwegian space companies have had with European Space Agency programs. The companies studied acquired benefits in the form of technology transfer related to work methods and development of new capabilities, which were noted to have applications in other non space related areas. The thesis found a limited amount of evidence for spinoffs and spillovers to other companies and industrial sectors. It is important to note that the firms` existing capabilities were a determining factor for the utilization of the economic benefits of participating in the European Space Agency programs.

Keywords:

The European Space Agency, Norwegian Space Centre, Capabilities, Core Competencies, User-Producer Relationship, Spillovers, Economies of Scale and Scope, Technology Transfer

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Table of Contents

Abstract II

Acknowledgement III

Table of Contents IV

List of Figures and Tables VII

1 Introduction 1

2 Theory 5

2.1 Theoretical Framework 6
2.2 Technology Transfer 8
2.3 Product Innovation and User-Producer Interaction 10
2.4 Absorptive Capacity 12
2.5 Capability Development 13
2.6 Building up Structure of Capabilities 14
2.7 Economies of Scale and Scope 15
2.8 First Movers 17
2.9 Spillovers and Economic Growth 19
2.10 Internal Spillover, Exploiting Capabilities for Company Growth 21

3 Methodology 24

3.1 Research Design 25
3.2 Sources and Collection of Data 26
3.3 Documents 27
3.4 Interview 27
3.5 Research Design Quality 28

4 Background 30

4.1.1 Norway's Long-Term Plan 2008-2011 for Space Activities 30
4.1.2 The European Space Agency 31
4.1.3 The Norwegian Space Centre 32

5 Case Companies 33

5.1 Norspace 34
5.1.1 ESA has Contributed with Methods and Structure 35
5.1.2 Initial Disadvantages Become Advantages 35
5.1.3 Capability Development from Utilizing the Firm`s Existing Competence 36

5.1.4 Using Technology Developed in the Past on Today's Products 37
5.1.5 Financial Funding and Stability 37
5.1.6 The Outcome from ESA Contracts 38
5.2 EIDEL 38
5.2.1 Interaction and the Difficulty to Enter the Space Market 39
5.2.2 Gaining More General Knowledge than Technical Aspects 40
5.2.3 Space Projects Attract More Applications for Work Positions 41
5.2.4 Developed Products for ESA, Application in Later Commercialization 41
5.2.5 The Reuse of Technology and Products Secures Stability 42
5.2.6 Companies are Investing to Gain Synergies 43
5.3 Kongsberg Defence & Aerospace 43
5.3.1 Interaction, Network and Policy`s Important Functions 44
5.3.2 Space Projects Have a Higher Demand for Reliability 45
5.3.3 Capability Developed Into Corporate Culture on Multi Disciplinary Subjects . 46
5.3.4 ESA Contracts Generated Spin Offs and Spin Inns 47
5.3.5 Affecting Other Projects Extending Beyond the Reuse of Technology 47
5.4 Gamma Medica 48
5.4.1 Complicated Process and User-Producer Relationship 49
5.4.2 Interests and Requirements Differ Extreme VS Minimum 50
5.4.3 Intellectual Property an Obstacle for Collaboration 50
5.4.4 Overlap between Space and Medical Equipment 51
5.4.5 ESA Contracts Have Been Disappointing 51
5.5 Nammo Raufoss 52
5.5.1 Easy to Contact and to Cooperate 53
5.5.2 Good Interaction in a User-Producer Relationship Leads to Possibilities 54
5.5.3 Long Experience and Little Competition 55
5.5.4 Developing New Skills 55
5.5.5 All about the Future Possibilities 56
5.5.6 Focus on Core Business 56
6 Analyze 58
6.1.1 ESA Contracts in Relation to the Theoretical Framework 58
6.1.2 Technology Transfer 58
6.1.3 Capability Development 61
6.1.4 Spillover 63
6.1.5 Policy Implications 65
6.2 The Case Companies have Gained Benefits from ESA Contracts 66
6.3 Empirical Findings 67

7 Conclusion ... 69

7.1 Technology Transfer ... 70
7.2 Capability Development ... 71
7.3 Spill Over ... 72
7.4 Potential Use of the Research, Findings and Recommendations ... 73

8 Reference ... 76

8.1 Appendix 1: List of respondents from the formal interviews ... 81
8.2 Appendix 2: Interview guide ... 82

List of Figures and Tables

Figure 1 Theoretical Framework........ 6

Figure 2 Part, 1 Technology transfer........ 6

Figure 3 Part 2, Capability Development........ 7

Figure 4 Part 3, Spillover........ 7

Figure 5 Theoretical Framework Technology Transfer........ 8

Figure 6 Theoretical Framework, Capability Development........ 13

Figure 7 Theoretical Framework, Spillover........ 19

Figure 8 Theoretical Framework........ 23

Figure 9 Theoretical Framework Technology Transfer........ 58

Figure 10 Theoretical Framework, Capability Development........ 61

Figure 11 Theoretical Framework, Spillover........ 63

Table 1 Overview of all case companies benefits from ESA contracts........ 68

Table 2 List of respondents from the formal interviews........ 81

1 Introduction

This thesis looks at what economic benefits Norway gains from participating in European Space Agency (ESA) programs. ESA is an agency whose stated mission is “To shape the development of Europe’s space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world” (ESA, 2010a). Although ESA is concerned with the scientific and social value of space activity, it also acknowledges that involvement in space activity might bring considerable economic benefits. Moreover, to ensure that these benefits are divided among the participating nations, the ESA-system operates on geographical return: ESA invests an amount equivalent to each member state’s contribution to the program, in industrial contracts for space programs within that country. According to Giuseppe Morsillo, head of ESA's Policy Office, there is a considerable political interest in Europe in the exchange of technology from the space industry to other sectors (ESA, 2010b).

Norway has been a member of ESA since 1987 and has according to the Norwegian Ministry of Trade and Industry contributed with “substantial funding to the European Space Agency programs” (Government, 2010) The public funding of space activities that Norway participates in through ESA is administrated by the Norwegian Space Center (NSC). Each year the Norwegian space center allocates national funding for space activities. Some of that funding is channeled directly into space activities through the European Space Agency, while another part is allocated to support programs for the Norwegian industry, to help strengthen their competitiveness for the ESA procurement system that awards the ESA contracts. For the year 2011, the Norwegian government has suggested in their budget to fund space activities with NOK 682.1 million, out of which NOK 131.8 million is allocated to mandatory ESA programs (St. Prop. (2010–2011), p. 106). Considering the size of the budget and the emphasis that the NSC has on acquiring economic benefits from space activity, the following questions can be stated that will serve as the thesis research questions:

- What economic benefits does Norway gain from participating in the European Space Agency programs?
- How can these economic benefits, be enhanced by altering the means through which the Norwegian Space industry is involved in these programs?

These research questions are important because the Norwegian government needs to legitimize using tax payer`s money to fund public agencies like ESA and NSC and to support the Norwegian space industry. The Norwegian government justifies funding of space activities, among others, by citing the economic benefits that might be generated by utilizing space technology in other sectors (NSC, 2008). Therefore, the government regularly conducts evaluation studies about their investments and their efficiency. According to the Ministry of Trade and Industry, investments in space activities have benefited companies beyond the space industry and resulted in many contracts for other Norwegian high technological companies (St. Prop. 1 (2010–2011), p. 106).

The Norwegian Space Center has previously conducted evaluation studies measuring the benefits of participation in ESA. These studies have applied quantitative methods, and the reports are based on statistics, like ESA generated sale compared with funding. NSC acknowledges that other benefits exist, and that these studies focus on the size of the reported sales value.

The quantitative methods used to measure benefits from ESA contracts, are weak on context. Only measuring the size of ESA sales, provides limited information about what these benefits contain like scope and effects, and the relation between the measured values.

This thesis applies qualitative methods and one of the advantages of this method is providing context and may therefore be able to find benefits that are difficult to measure and quantify, and describe what they consist of and how they occur. Qualitative methods can contribute knowledge that cannot be extracted from statistics like accessing people's "constructions of reality" of a situation such as their perceptions and meanings (Punch 2008, p. 168). Getting an inside view, or as argued by Punch, the "actors definition of the situation" is carried out best through qualitative methods (Punch, 2009, p. 238). This thesis studies the economic benefits Norwegian companies gain from participating in the European Space Agency programs by using qualitative methods, such as in-depth interviews with five selected case companies: Norspace, Eidel, Kongsberg Defence & Aerospace, Gamma Medica, and Nammo Raufoss. The advantages of using this method is that the thesis not only is able to find that these companies have benefitted from participating in the European Space Agency programs, but also how and why they have benefitted. Such results may enhance the validity of previous statistical findings, and thereby provide a more detailed picture. Nevertheless, it is important to notice that by using qualitative methods it is not possible to measure the extent of the economic benefits in the same way as quantitative methods can.

The thesis looks at three innovation mechanisms, technology transfer, capability development, and spillovers that might describe how companies could benefit from ESA contracts:

- Technology transfer: contracts can transfer competence and capabilities from ESA to the Norwegian space industry, benefiting companies that are able to develop new or enhance existing capabilities.
- Capability development: companies can acquire new capabilities from learning by doing, increasing the core competence of the company.

- Spillovers: companies can benefit from technology transfer and capability development, which in turn can lead to internal spillover and result in external synergies.

This thesis acknowledges the possibility that benefits can occur in other ways.

This thesis is structured in the following way. In chapter two, a theoretical framework in relation to technology transfer, capability development, and spillover is described. The thesis applies a case study design with focus on qualitative research methods and in-depth interviews with core personnel. The case study design and method is described in chapter three. In chapter four, some background information about ESA, NSC and Norwegian space activities is provided, and in chapter five, case studies of five different space companies are detailed (Norspace, Eidel, Kongsberg Defence & Aerospace, Gamma Medica and Nammo Raufoss), and analyzed in chapter six. Finally, in chapter seven, the empirical findings are stated, in the form of recommendations and remarks, and a conclusion is drawn on the potential use of the research.

2 Theory

This thesis uses a theoretical framework from innovation studies in relation to how economic benefits are derived and enhanced. There is a diversity of views on how such synergies and benefits can occur, depending on the interest of the institution, leading to a wide range of applicable frameworks on how economical benefits from technology programs can be investigated. Considering how ESA participation can contribute to industrial growth and synergies in Norway has narrowed the choices of applicable innovation theories in a natural way.

The theoretical framework of technology transfer, capability development, and spillover as shown in figure 1, illustrates three ways in which technology transfer, from ESA to the participating companies through contracts can increase a company's capabilities. The thesis has developed this theoretical framework, in order to analyze the empirical findings, in regard to what type of benefits Norwegian companies have gained from Norway's participation in ESA programs.

In this chapter I will present theories from Rosenberg on technology transfer, Teece, Pisano and Shuen`s theories of capability development and Henderson & Cockburn`s theories of Spillover to construct a theoretical framework based on these theories.

2.1 Theoretical Framework

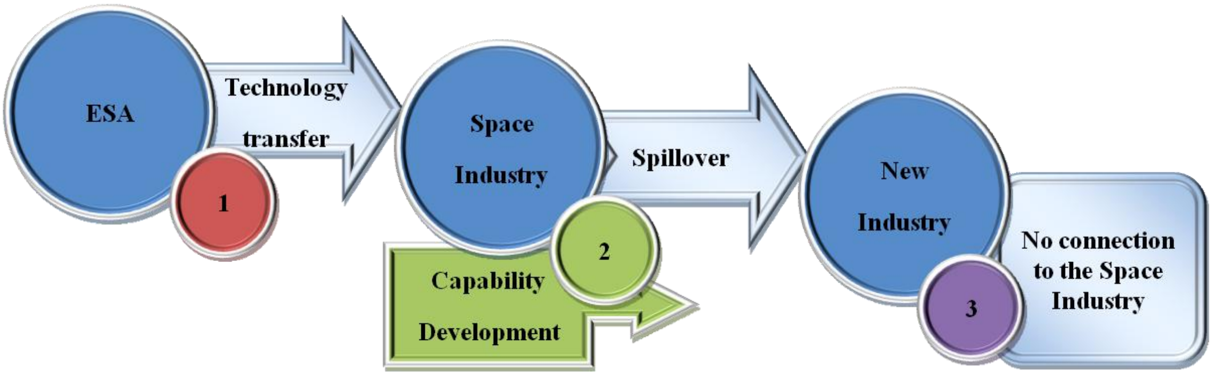


Figure 1 Theoretical Framework

The above mentioned scholars examine three ways benefits might be generated, focusing first on technology transfer and a user producer relationship, second on internal capability development and economies of scale and scope, and third on spillover from the firm`s space activities. Each of the three theories is further discussed in detail in part 1 technology Transfer, part 2 capability development, and part 3 spillover.

Part 1, Technology transfer

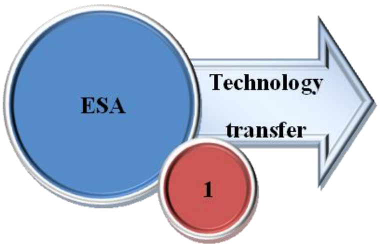
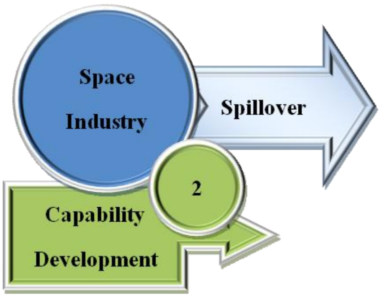


Figure 2 Part, 1 Technology transfer

Discuss theory from Rosenberg on Technology transfer, Lundvall on user-producer relationship and Cohen & Levinthal on absorptive capacity.

The term technology described the use of knowledge to accomplish a particular task while technology transfer is the application of knowledge. The definition of technology transfer in this thesis is the transfer of technologies, methods, knowledge or facilities developed for one purpose, for reuse on new or different purposes.

Part 2, Capability Development

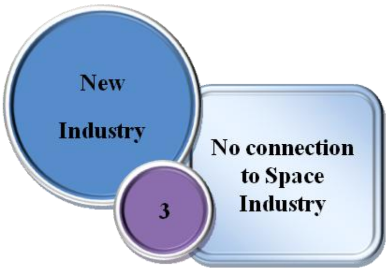


Discuss Teece, Pisano, Shuen`s theory on Capability Development, and Chandler on the economies of scale and scope.

Figure 3 Part 2, Capability Development

Capability is knowledge gained through learning from projects in the past. Capability Development is accomplished through learning by doing. The firm, its organization, and its individuals, use their own competence and external sources to develop technology and products through an iterative process of design and evaluation. Through successes and failure, they learn from these past projects and develop new capabilities over time.

Part 3, Spillover



Discuss Henderson & Cockburn Spillover theory.

Figure 4 Part 3, Spillover

Spillover is the application of knowledge, such as competence and capability in the form of technology, product or method, gained from working on a project in one core area to another unrelated area. Spillover can occur internally by reusing technology and externally by diffusion of knowledge. This diffusion could establish new markets for the company that developed the technology but this would be an organizational matter and not an external spillover. External spillover should ideally be to a new company or sector that has no ties to the origin of the developed technology.

This thesis applies these theories and definitions to analyze the empirical findings from the participating firm investigating what ESA contracts have transferred to the companies, what kind of knowledge in the form of capability development the firms have acquired and what types of internal or external spillover and synergies this has generated.

2.2 Technology Transfer

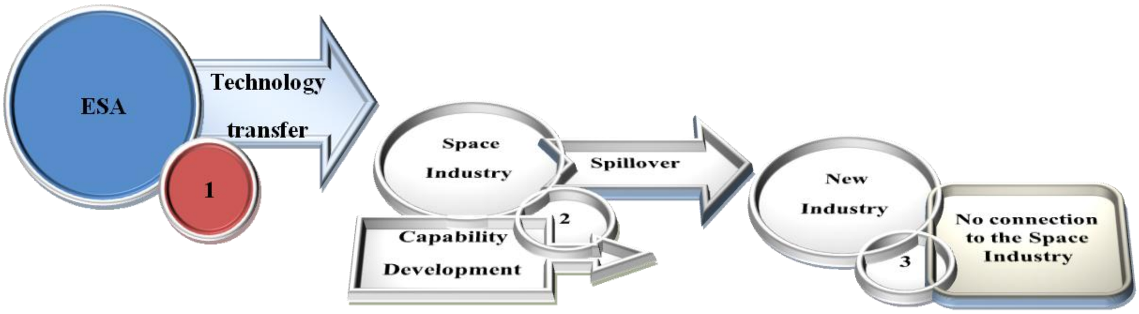


Figure 5 Theoretical Framework Technology Transfer

Rosenberg (2010, p. 72) claims that there is more to economic growth than just a process of mere replication, because the transferred technology has to be adapted. The same process that has been used in the development of a new technology is not necessarily the best possible process when transferring the technology. In other words, this means that one successful process is difficult to replicate and transfer because it has to be adjusted to local conditions such as the receiver's capability to receive. This capability is a capacity to utilize the technical knowledge and it is essential as Rosenberg (2010, p. 76) points out for a successful incorporation "in the economist production function". It also may be clearer after the technology is developed that there are better ways to utilize the developed technology than at the time of development.

Transmitting technologies from one company and using it elsewhere, always presents certain elements of novelty according to Rosenberg (2010, p. 73). In areas such as the machine tools industry, for example, technology transfer between industries resulted in specialization by process rather than in products. From one industry to another, transferring technological knowledge, such as new uses of known techniques, added to the company's knowledge. Individual firms mostly did this because standardization was missing at the time, and adapting the technology and organization of mass production made the process complicated. This means that infrastructure such as standardizations are essential for technology transfer. Rosenberg claims, "Clearly there is no single "best-way-of-doing-things" to which we have rigidly adhered in all sectors of our economic life", mean that a strict and single optimal way of doing things does clearly not exist (Rosenberg, 2010, p. 96). In addition, Technology transfer also differs according to which sector it is transferred in. For example, the industrial transfer is easier than it is within agricultural technology, because the industrial system is more open and more "dependence upon human inputs" as noted by Rosenberg (2010, p. 91).

Kline & Rosenberg (2010, pp. 200-201) points out in his conclusions that it is "unthinkable for successful technical innovations to be created today without utilizing significant inputs from the stored technical knowledge in science and other forms of thought" (Kline & Rosenberg, 2010, p. 200). This underlines the importance of a firms "stored knowledge" and "forms of thoughts", the firm's capabilities, and the utilization of their capabilities inputs. These inputs, such as knowledge, are absorbed by the organization in a firm. This knowledge enters mainly through knowledge that has already been obtained by employees, rather than from quickly accessible knowledge. An organization utilizes their capabilities based on their present employees absorbed knowledge and when their capabilities are insufficient to solve a task, research is needed. New competence from outside the firm can be gained buying technology or hiring skilled engineers.

Technology transfer can contribute a wide range of benefits for a firm such as increasing competence and knowledge, and improving methods or product performance. It can reduce costs, lead to increased financial revenue, or generate stability from income and a non fluctuating market. Given that not all benefits from technology transfer are generated through a process of physical transfer of a technology, a company's organizations can also benefit from other indirect transfers such as the transfer of methods and knowledge.

The benefits from some space technology transfers accruing today can be measured and listed, but according to Brisson, Bougharouat & Doblas (2000) it is "extremely difficult to develop a fully comprehensive list". For example, adaption of space technologies and the reuse of developed products by a company save costs, but this reuse of technology reduce the cost of manufacturing and production, and the training of employees in methods and quality, which increases the firm's competence. There are many cost savings for companies to achieve from technology transfer, which are difficult to list and may originate from a non physical transfer. Some economical returns are measurable, but the returns such as increased awareness of the companies own technology and increase of their capabilities are much more difficult to measure.

2.3 Product Innovation and User-Producer Interaction

Production is a process with a regular flow of products from producers to users. There are several user-producer relationships and in this thesis, the user is a professional one. In a commercial market, the producer will conduct market research to uncover the consumer's needs, using this knowledge to develop new and improved processes and products in these markets. New knowledge increases companies stockpile of knowledge "either as the result of internal experience, for example - as results of learning-by-doing or learning-by-using and, as the result of information brought into the organization from external units" (Lundvall, 1985, p. 7).

Developing new products means that the regular production process technology might need to be adjusted to solve the user's needs. Having access to information about the user needs beyond specifications is vital, the producer is also interested in sharing information with the users about competence, reliability, and product innovations. Users can buy certain products off the shelf: those are typically low priced standard products. Specialized and expensive products need, according to Lundvall (1985, p. 10), a process of user producer cooperation. ESA, as the user, provides the producer with specific requirements for a new product. The product been specialized which means that the user may depend on the future of the producer. Therefore, the user is interested in monitoring the producer's competency and reliability, and reinforcing the cooperation and as Lundvall (1985, p. 11) point out their relationship is mutually interdependent in a complex way.

Many producers achieve process innovations without extra costs, because these innovations originate from reflected learning such as learning-by-doing and learning-by-using, but the small scale of operation involved in process innovations limits the benefits for the producer unit. Since new process have no external market, producers benefit mainly from cost reductions. In a way, process innovations are limited because they are based on one single user's experiences and needs.

On the contrary, it enables product innovations to use several user experiences as input for the innovation process. For product innovations, where one producer has to relate to one or few users, Lundvall (1985, p. 13) claims that the involved uncertainty and complexity can be found in the product itself. The user has to assess how the product will affect performance and what services the producer shall deliver in the future. If the user integrates the producer, the user will reduce the uncertainty, for example through a contract, the user can access the technical competence of the producer.

According to Lundvall (1985, p. 27), it is a virtuous circle with cumulative consequences that both users and producers are learning-by-interacting and such mechanisms result in stability. In addition, this interaction "creates poles of competitiveness" because it reflects the knowledge between user and producer. A weak user-producer relationship might give small marginal returns even with an increase in contracts. Many of the benefits are intangible, so it is vital to have strong relationships. Successful utilization depends on the user-producer interaction, and stabile relationships usually have good interactions. In strategies, this relationship is an important aspect for the firm as pointed out by Lundvall (1985, p. 36).

2.4 Absorptive Capacity

According to Cohen & Levinthal (1990), absorptive capacity is not only the acquisition or assimilation of information by the organization but also the organizations ability to explore it. A company's competence and dynamic capability is the collection of routines, skills, and complementary assets, providing a competitive advantage only when they are difficult to replicate (IP, cost of machinery or little knowledge mobility). It is relevant to understand how the company's knowledge is developed and protected. Before you can explore, you need to have an ability to know what you can utilize before starting to search for new information. Kim (1997) suggested using the concept of technological capability to analyze companies, though the concept has also been applied to industries and countries. The concept is defined as "the ability to make effective use of technological knowledge in efforts to assimilate, use adapt and change existing technologies." (Kim, 1997, p. 4), which is quite similar to the definition of the absorptive capacity "The ability of a firm to recognize the value of a new, external information, assimilate it and apply it to commercial ends" (Cohen and Levinthal, 1990, p. 128).

The ability to exploit external knowledge is the absorptive capacity of a company and the dynamic capability is the ability to achieve new forms of competitive advantages. These concepts have overlaps, for example, they include aspects related to skill formation and finance. Kim (1997), Cohen & Levinthal (1990) and Teece & Pisano & Shuen (1997) agree on the importance of capacity, capability and management when exploiting new knowledge.

2.5 Capability Development

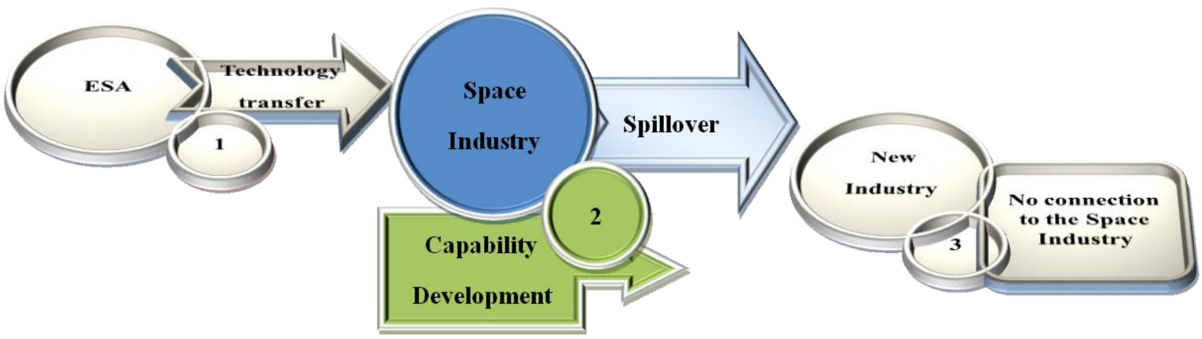


Figure 6 Theoretical Framework, Capability Development

Nick von Tunzelmann from the SPRU center held a lecture in May 2010 at Nordic Institute for Studies in Innovation, Research and Education. During this lecture he said that while "competence reflects possibility, capabilities are realized". He indicated that there is a difference between the terms "competence" and "capabilities" and while competence is learning by searching, capabilities are learning by doing. A firm's competence represents an asset that can be acquired in the firm and from elsewhere, representing possibilities for the future.

High technology industries have according to Teece, Pisano and Shuen (1997), to demonstrate rapid and flexible product innovation and management capability, such as effective coordination and reuse of internal and external competence. By redeploying competence, searching for new possibilities, and by reusing technology and products, a firm also reuses capability, existing knowledge that is already realized, in order to innovate successfully.

The firm`s capability is knowledge learned from projects in the past, thereby representing the expertise of a firm. The capability affects the type of competence that can be acquired and how the firm's competence can be altered. When a firm gains new competence, it affects the capability not at once but after some time has passed. When a firm has searched for a certain needed competence, it has to absorb and adjust to the new or increased knowledge, regardless of what competence it had before. Therefore, before a firm can utilize their new competence they must acquire the competence. This transfer can occur through hiring new skilled employees. The firm then uses its capabilities to absorb the transfer of knowledge or methods the new employees bring with them. No matter how the transfer is accomplished, the firm has to absorb the transfer and this is called absorptive capacity. This absorptive capacity is unique to each company.

2.6 Building up Structure of Capabilities

According to Kline and Rosenberg (2010, p. 173), commercial innovation is all about two forces that interrelate in unpredictable ways. The market forces have factors such as continual changes in commercial opportunities, and changes in incomes and relative prices. The forces of progress often seek possibilities to develop new products, improve exciting products, or reduce production costs. For a firm to achieve a successful outcome from a developed product, it has to master both the technological and commercial sides of innovation. Replication of transferred technology is difficult. It is important to identifying the foundations to build, maintain, and enhance capabilities in the firm. Replication takes time, and it may even be illusive when replicating the best practices. When searching to explore and exploit new technology or knowledge, capabilities to manage them are needed. Understanding what the company already has obtained and what is still required to utilize the new information to generate innovation can be vital. Scholars like Teece, Pisano and Shuen (1997), have discussed and compared different models of strategy and their approaches. These approaches are in many ways complementary, the dynamic capabilities approach has the advantage that it emphasizes fields like management of R&D and technology transfer, compared to traditional approaches (for example resource based) that view these fields to be outside the traditional boundaries of strategy issues.

Structures involve elements that are relatively stable over time. Nevertheless, for many technologies, especially novel ones, these structures are not in place. Academics have enriched the literature on different systems for technological innovations. Studies of these systems indicate focus on building up structures and capabilities over time. A central idea of these approaches is to consider all activities that contribute to the development, diffusion, and use of innovation as a system functions. The differences lie mostly in what to include in the system, views on what to consider as contributions vary accordingly to factors like the technology and region. According to Powell and Grodal (2005, pp. 57-60) several studies have shown that networks are important and provide access to information and capabilities, and those relationships develop a greater commitment and a more systematic knowledge sharing.

2.7 Economies of Scale and Scope

Increases of production leading to cost savings are advantages defined as economies of scale. Common advantages from economies of scale are reduced administrative costs and manufacturing cost per unit. Larger companies can often produce products cheaper than small companies can if everything else is equal, however economic of scale do not occur just because a company is large. A collection of units in a firm, each operating with its own specific facilities and personnel are defined by Chandler (1990, p. 15) as operating units. He claims that adding new units with different economic functions, made firms multifunctional and this lead to company growth. The addition leads to cost savings in production, and firms can “maintain a long-term rate of return on investment” (Chandler, 1990, p. 15).

Production costs are reduced for many different reasons, but one of them is the transfer of facilities and skills to more profitable markets. Through technology transfer, companies improve functional efficiency in specific units, such as production improving performance of existing products, and processes, developing new ones. This growth process provides the firm with an internal dynamic allowing the company to be powerful and adapted to changes in technology and markets. These operating units in the economics of scale and scope are closely connected to efficient utilization of facilities and skills, where scale means an increased number of products in the production, and scope means that multiple products are using one process for production. This means that by exploiting the economies of scale and scope it is possible to reduce the unit cost of production resulting in efficient resource utilization and costs savings.

Production units typical benefit from scale since a higher production volume reduces the unit costs, but the benefits from scope also lead to significant cost reductions because more products use the same intermediate processes as noted by Chandler (1990, p. 24). Furthermore, he claims that the amount of processed products in a specified time line, determines the cost, and the gained profits are capacity and throughput. Scale economies depend on size and speed, the rated capacity, measures the production facilities physical characteristics. Throughput demand continual monitoring and coordination from a management team to be effective. In economies of scale or scope, throughput is organizational, depending on “knowledge, skill, experience, and teamwork-on the organized human capabilities essential to exploit the potential of technological processes" and to exploit the cost advantages of scale and scope companies have to invest in these (Chandler, 1990, p. 24). An example given by Chandler is that some companies were able to reduce their price of one product (Dye), even when adding new products, by slightly increasing the costs of production but reducing the cost of each unit. Nevertheless, developing new products is costly and it increases tasks such as coordination and quality control. Chandler emphasizes that the final investment in building a company is the "recruiting and organizing of the managers needed to supervise functional activities" of processes and products (Chandler, 1990, p.31).

2.8 First Movers

First movers are the initial occupant (a particular company) in a market, and Liebermann & Montgomery definition of first mover advantages is "the ability of pioneering firms to earn positive economic profits", Liebermann & Montgomery (1987, p. 1). When a company is first to the market, it can acquired powerful competitive advantages such as building a strong brand and developing economies of scale establishing infrastructure such as distribution channels. This multistage process is the firm's ability to acquire positive profits from being new on a market, gaining a head start against other firms. Some scholars such as Liebermann & Montgomery (1987, p. 2) note that first mover advantages, arising from sources such as technological leadership, are advantages derived from the firm's experience, meaning that their learning curve has decreased their costs through a cumulative output (economies of scale). The first movers firms can also preempt scarce assets and thereby gain advantages over other firms because they are controlling access to resources (facilities).

These first movers' advantages are typical for industries using new or improved processes to produce new or improved products. The late comers have to compete with the first movers in many aspects, such as conducting necessary investments. Building the management is a challenging task, because recruiting and training the latecomer's management means that the latecomers are learning unique characteristics of new or improved technologies while the first movers are already practiced on the market. While the first movers cost advantages of economies of scale and scope is important, they also are further down the learning curve and are before the late comers in every functional activity. The first movers have already developed these capabilities enabling them to acquire and develop the needed facilities and skills, and thereby allowing their companies to grow faster.

According to Chandler (1990, p. 36) the combined management's skills is considered to be the capabilities of the organizations, and is the most valuable asset. By providing profit, these capabilities lead to the financing and continuing growth of the firm. Once the investments in production and the necessary management are in place to exploit the economies of scale or scope, the firm can grow. One way is to produce new products connected to the company's existing technologies. The use of existing facilities and organizational capabilities provides the company with a competitive advantage. The firms acquired skills and capabilities could be transferable, and the improved processes and development of products originated from the needed scientific training of improving machinery could be applicable to other areas.

As Chandler (1990, p. 42) claims, companies that master the needed specialized technical and organizational skills to commercialize a product, understand the complexities and importance of long-term performance. There are many different aspects to manage, such as deciding on extensive necessary investments needed to commercialize a product when it could take several years to make a profit. Organizational capabilities that have been established have to be maintained. Changes in technologies and markets can lead to facilities and skills becoming obsolete. Integrating these capabilities as Chandler point out "into a unified organization-so that the whole becomes more than the sum of its parts" contributing to growth of the firm (Chandler, 1990, p. 594).

2.9 Spillovers and Economic Growth

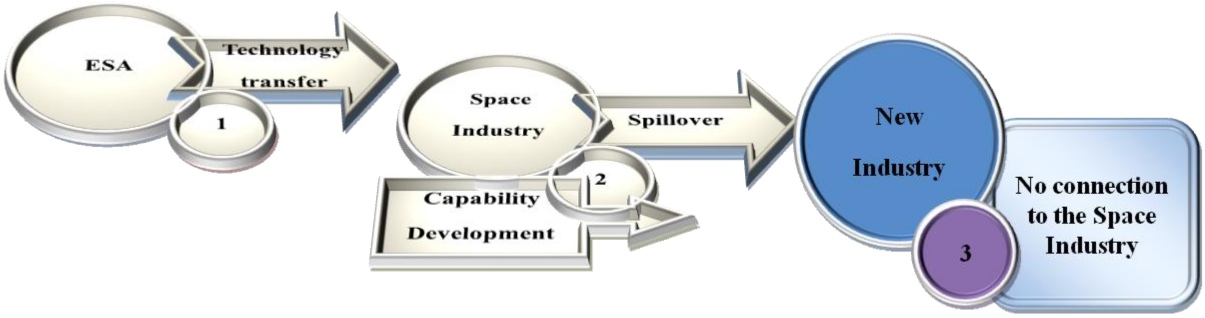


Figure 7 Theoretical Framework, Spillover

Companies may have a diversity of benefits arising from discoveries in one project, which can stimulate the output of another project. This spillover is the reuse of acquired knowledge. There are different methods of spillover: the internal spillover between projects in a company, external spillovers between firms on the same project, and external spillovers outside the industry. According to Henderson & Cockburn (1996, p. 37), acquired knowledge is likely to have implications (spillover) to projects elsewhere in the firm and that the knowledge spillovers between firms are drivers of economic growth, described in modern theory. Mowery and Rosenberg (1989, pp. 137-140) question whether it is possible that military and space R&D technology allows for the exploitation of spillovers to commercial applications because this kind of technology is very specific, and the requirements for military use are quite different than those of the commercial market. In the economics of industrial organization, there are according to Henderson & Cockburn (1996, p. 32) two central problems. First, in the analysis of industrial structure, the size of a company is connected to their innovative performance. Second, in the theory of the firm, the economies of scale and scope in R&D are important, and problems in the market for information are fundamental in the existence of multiproduct companies (Arrow, 1962; Teece, 1980; Cohen & Levinthal, 1989).

The size of a company, may determine the company's ability to "exploit economies of scale and scope in the conduct of research itself" (Panzar & Willig, 1981; Schumpeter, 1950). Henderson & Cockburn (1996, p. 33) say that large companies appear to have an advantage, in their ability to realize returns to scope, such as capturing and utilization of both internal and external spillovers of knowledge. This is more important for research technology based industry. Spillovers between firms in industry are quite substantial according to Henderson and Cockburn (1996) and furthermore in several models of market structure, spillovers from R&D play a key role as noted by (Spence, 1984; Dasgupta & Stiglitz, 1980), although, the impact is difficult to estimate. Spillover from other industries has influences through input costs, which affect the productivity of research, but it also increases the total knowledge available to research. Distinguishing between these sources is difficult and hard to measure. However, as Henderson and Cockburn (1996, p. 34) claim, the productivity in research conducted by firms significantly correlates with the public sector generated knowledge. In addition, R&D requirements are different for research and for development considering the used sets of skills and resources.

It is often required in high technology research to invest in substantial fixed costs, because of the complexity. Through higher fixed costs, such as investments in large pieces of equipment, and by increased use and spreading of the research activities, it is possible to gain economies of scale. Larger firms have the possibility to gain these advantages through the firm's ability to support specialized personnel. A firm can obtain economies of scope when the firm's activities can share inputs without additional costs. The firm accumulates knowledge (competence and capabilities), and it can benefit from internal knowledge spillover when reusing this knowledge on different projects with little or no additional costs. This could enhance each of the projects productivity: however, the ability to utilize internal economies of scope determines the productivity.

2.10 Internal Spillover, Exploiting Capabilities for Company Growth

One important issue for a company’s management is to grow profitability over a long term. Understanding the core and, focusing on the company’s core business, leads to sustained and profitable growth according to Zook & Allen (2010, p. 14). They define the core business as set of capabilities, customers, channels that the firm uses to grow revenue sustainable and profitably.

According to Mowery & Nelson (1999, p. 6), suppliers and customers working together, in a region or in other forms of networks, reinforce capabilities throughout this interaction. The networks that are without a geographical proximity often exist with specialized labor and government support programs such as the ESA, NSC and Norwegian companies through an ESA contract. This interaction with demanding and knowledgeable actors improves a suppliers innovative and competitive performance, as noted by Porter (1990, p. 585), Mowery & Nelson (1999, p. 6). The firm`s utilize their existing core and capabilities, in combined with knowledge and experience from an ESA contract.
Internal spillover from technology transfer like structure and methods, together with a good user producer relationship, lead to situations where it is possible to exploit new capabilities that can lead to cost savings and the reuse of knowledge to generate stability for a company.

Technology transfer needs to be adapted and adjusted to the receiver`s capability. The ability to share information and skills, absorptive capacity, existing knowledge and infrastructure like standardizations in the companies affects the success of the transfer and its utilization.

Technology transfer has two actors a sender and a receiver. The interaction in this user-producer relationship can determine the successful utilization of the transfer. Technology transfer can lead to cost savings from economies of scale and scope, improved product performance and improve methods or process. To exploit new technology or knowledge companies need capabilities as the replication or the utilization of transferred technology is difficult. Knowledge learned from projects in the past represents the expertise of a firm. This capability affects the type of competence that can be acquired and thereby replicated. Developing a new capability means using the existing competence and capability in a firm. Companies can benefit from economies of scale and scope, saving costs like reduced administrative costs and manufacturing cost per unit. First-movers companies that have preempted scarce recourses, like gaining access to facilities that are difficult to access today, benefit from being first on the market. Spillover is the reuse of acquired knowledge on other products and purposes. There are different methods of spillover: the internal spillover between projects in a company, external spillovers between firms on the same project, and external spillovers to and from outside the industry.

The theoretical framework`s three parts show how the selected case companies could benefit from ESA contracts. First part examines technology transfer from ESA contracts. Second part explores capability development in the companies. The third part describes how this could result in possible spillover.

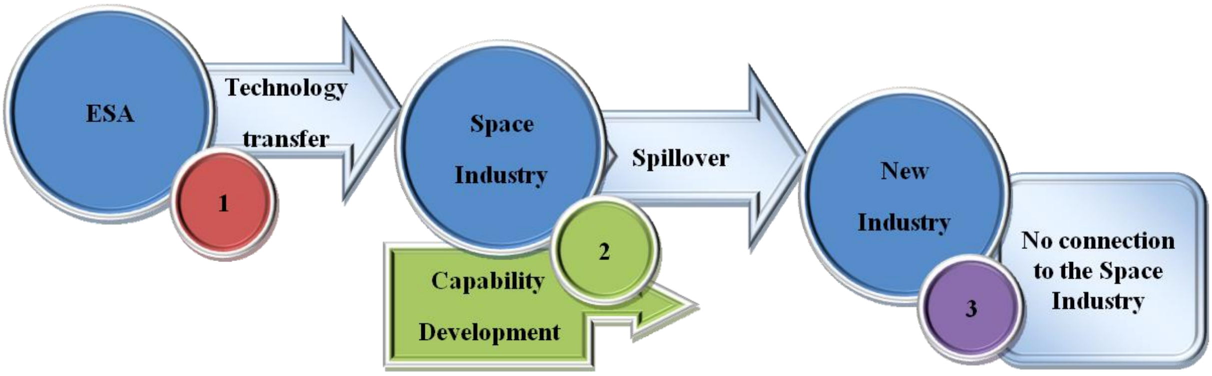


Figure 8 Theoretical Framework

According to the developed theoretical framework, technology transfers can provide synergies for companies that have the capability to utilize the transfer, and a good user-producer relationship. Case companies that are able to use their existing competence to work with capability development have acquired new capabilities in exploiting new technology. It is also possible that some of the case companies have first mover advantages, and are exploiting economies of scale and scope resulting in costs savings. The companies can gain internal spillover, like the reuse of knowledge, and external spillover, like new commercial products in other industry sectors. Using the theoretical framework helps to contextualize and clarify aspects in order to understand the empirical findings in this thesis.

In the next chapter, the basis for the methodological choices is discussed.

3 Methodology

This thesis uses qualitative methods, such as in-depth interviews of selected case companies to analyze how firms acquired benefits from ESA contracts. Because of the choice of research design and the time available for gathering data, it was only possible to interview five companies. Four of the firms are chosen from the evaluation report NRS-2010/1 produced by Norwegian Space Center (Amundsen & Eriksen, 2010, p. 5). In addition, another company was added, after the NSC suggested during an informal meeting that the company`s experience with ESA participation might prove to be valuable to the research project.

Using quantitative methods is, as Punch (2008, p. 3) notes, empirical research where the data are in the form of numbers. The case company`s core business operates mainly in segments other than space, which makes it difficult to measure benefits from ESA contracts solely in a quantitative manner with numbers, such as increased sales. Space is just a small part for most of these companies and their space activities, like development and production, continually intertwined with the core business activities.

According to Strauss (1987, p. 2), quantitative data contain a high variety of information; however, many times does not provide much insight on context. The use of a qualitative method is required to understand benefits that are difficult to measure, in order to determine what kind of benefits exist, and how they occur. This approach is useful and makes it possible to do in-depth interviews based on the presented experiences from the different actors.

Quantitative methods are not only weak on context they are also driven by the researchers concerns affecting their subjectivity, whereas qualitative research takes the subject`s perspective as the point of departure as noted by Punch (2008, p. 242). This approach is more useful in order to uncover the factors underlining the relationships of the benefits that have occurred.

Qualitative methods can contribute with knowledge that cannot be extracted from statistics. Quantitative studies compare many cases and generalize the empirical findings. Statistical generalization uses random selection of respondents, and in this thesis the respondents are selected precisely because of their experiences with ESA contracts.

The qualitative approach used in this thesis, examines a few (five) case companies. While this number is insufficient for quantitative methods, the findings provide a unique understanding rather than a broad result.

Existing studies have used quantitative methods; however, conducting qualitative research, can enhance the validity of previous findings, and thereby provides a more general picture. This process is called triangulations according to Punch (2008, p. 241).

3.1 Research Design

Case studies are suitable research strategy when using a contemporary phenomenon and as Yin (2009, p. 18) points out “Especially when the boundaries between phenomenon and context are not clearly evident”. In addition Yin (2009, pp. 11, 21) claims that case studies follow a set of pre-specified procedures when investigating an empirical topic and its unique strength is its ability to handle the variety of evidence like interviews, observations and documents.

The strengths of the chosen approach are well suited for the size and complexity of the space system (ESA, NSC and the Norwegian space industry), and the diversity of the empirical sources, consisting of interviews, reviewed documents and data from the internet. As noted by (Yin, 2009, p. 4), the case study approach contributes with knowledge like organizational structures and maturation of industries or related phenomena, which in many situations allows the investigator to use a holistic approach. According to Punch (2009, p. 238) getting an inside view or the ‘actors definition of the situation’ is carried out best through qualitative methods.

The approach is useful because it allows the researcher to carrying out in-depth interviews with the different actors to gain information about benefits from ESA contracts. As pointed out by Goode & Hatt (1952, p. 331) a case study is not a specific technique but it is a way of organizing social data and preserving the ‘unitary character’ of the investigated social object. Punch (2008, p. 168) says that in qualitative research one of the main data collecting tools is interviews, because it can be a good way of accessing people’s constructions of reality of situation such as their perceptions, meanings and definitions.

Furthermore, qualitative researchers use multiple methods and sources of data, for example interviews, observation participant observation, and documents. Yin (2009, p. 41) points out that using multiple sources of information for the case study increases the validity of the research and provides a greater amount of evidence making the results presented more convincing. Using many sources of evidence also ensures that the research avoids bias, which additionally supports the validity of this thesis. I have relied on qualitative methods of interviews and document analysis to answer my research question.

3.2 Sources and Collection of Data

I had to make several choices when deciding the focus of the study, since I only captured a specific part of the ESA collaboration, in particularly the economic benefits. Including too many actors could exceed the practical limitation of the case study. Therefore, I decided to focus on Norwegian firms involved in ESA contracts, in particularly those companies listed in the NRS-Report 2010/1. The report identifies 24 companies and research institutes in Norway resisted with an ESA-sale that could provide synergies such as spin offs. The report has three categories, and with 24 possible respondents, I had to decrease the number of respondents to a manageable size. It was clear from figure 1 in the report that the two of the tree categories had a small proportion of ESA-contracts; therefore, I selected to eliminate the categories of research institutes and service providers. I also had to consider accessibility of the respondents, and selected companies based on geographical location (interviews conducted near Oslo because of budget constraints), and whether they would provide public access to company information.

3.3 Documents

Document sources used in this thesis include various policy, strategy, scientific and consulting reports, and web pages from government, organizations and firms. These documents have also influenced the design of the interview guide. In my analysis, I hold a critical view on documents and particular reports that consist of interpretive information, publish and non-published for specific purpose.

3.4 Interview

To investigate what benefits different actors participating in ESA contracts have attained, I conducted five formal interviews and several informal interviews, in order to understanding each company`s position and role and how the system operates. The Norwegian Space center acting on behalf of the Norwegian government as the main public actor, and several meetings face to face and by telephone took place. I conducted informal interviews by engaging in conversations and asking questions during meetings, which were not recorded. However, I made it clear that my findings would be included as evidence for this work and that I would summarize the conversation and meeting afterwards in field notes.

First 10 companies were contacted, by e-mail`s and later by phone with the request to carry out an interview. Not all companies answered or consented to an interview, so in the end, six respondents from five companies participated. Five formal interviews were conducted using the English written interview guide, while conversing in the Norwegian language. When quoting the respondents, all answers were translated from Norwegian to English, and the translated answers were used in the following empirical case descriptions. Before carrying out interviews, an interview guide (see Appendix 2) was prepared to assist throughout the interviews of the six respondents. Those interviewed represent member of top-level management from each firm's space activities. The interview guide was adjusted during the interviews according to the respondent's answers, in the search for understanding and evidence. In offering all companies anonymity, at start only one company wanted to be anonymous, however after the general manager had read the case-description he decided that anonymity was not required.

Four of five interviews were recorded, while the answers from one interview were written down directly after request from the respondent because of company rules (Kongsberg Defence & Aerospace AS). The case description of the recorded interviews was send to the respondents for feedback and comments.

3.5 Research Design Quality

Scholars that are against using case studies argue according to Yin (2009, p. 41) repeatedly that the investigator fail to have an objective judgment to the collected data. By the use of several sources of evidence, chain of evidence and feedback from key-informants reviewing the case study report, should secure the needed objective of this thesis.

It is important that the result of the thesis is testable and that it has the same outcome. To secure the reliability of this thesis, the investigator must work in a structured manner.

Therefore, before carrying out the data collection, a case study report, thesis outline, time schedule, interview guide was prepared. Also the possibility to conduct a secondary analysis allows other investigators to study the raw data which increases the reliability of the study, according to Yin (2009, p. 45). Transparency is important for both the applied method and references, to contribute the necessary information that allows repeated research to achieve the same results.

Through the research process the research design has been adjusted and reflections on the collected data have contributed to a new theoretical view and understanding.

In the next chapter, the context is described more closely.

4 Background

The thesis explores the background of the public actors to set the context and frame the funding system. Norway as a nation is not new to space activities. One might say that Norway became a space nation as early as in 1962, when the first research-rocket was launch from Andøya. Moreover, Norway has wanted to develop and grow their national space industry from that time onwards. Joining the European Space Agency in 1987, Norway sought to generate higher industrial growth in the space industries, with the hopes that companies outside the space industry would also be able to realize benefits. According to the Norwegian government, the Norwegian participation in ESA secures access to technology and strong competitive conditions on the space market, resulting in many ESA contracts for Norwegian high technological companies (Government, 2010).

4.1.1 Norway's Long-Term Plan 2008-2011 for Space Activities

The Norwegian long-term plan for space activities, 2008-2011, states that Norway is among the countries in the world with the largest need, benefits, and conditions for exploiting space capabilities. These needs are largely due to a combination of geographical features such as, large ocean areas, large marine sector, climate, and topography, small and dispersed population, combined with high levels of competence, high technology and high-level security requirements in society.

The overall objective of Norwegian space activities is to provide essential and sustained contributions to increased value in creation, innovation, knowledge development, and environmental and societal security (NSC, 2008). The overall goal is broken down into main objectives, for example annual industrial and commercial growth of 10 percent. A viable innovative space industry will in the future require sustained public investment as noted in the long-term plan. The public efforts are essential to ensure stability of established markets and the growth of new ones for Norwegian-produced space utilities and space services (NSC, 2008)

4.1.2 The European Space Agency

The convention for establishment of a European Space Agency (CSE/CS (73)19, rev.7) agreement was signed in Paris France, on the 30th of May 1975 and ratified by Norway on the 30 December of 1986 (ESA, 2005). The European Space Agency is an international organization with 18 member states, and the current Director General of the Agency is Jean-Jacques Dordain from France (ESA, 2010a). The Council is ESA`s governing body and it provides the basic policy guidelines to develop European space programs. Each member state has one vote regardless of its size or financial contribution. According to ESA, the financial contribution from each member state is calculated in accordance with each country's gross national product. It funds all mandatory activities such as space science programs and the general budget (ESA, 2010a). Additionally, ESA conducts a number of optional programs that each member state can decide to participate in and specify the amount they wish to contribute. The ESA-budget for 2010 is €3745 million and 90% of the budget is spent on industrial contracts, amounting to approximately 1000 contracts placed with European and Canadian companies every year (ESA, 2010a: ESA 2009).

The agency's major obligation is to design, define and conduct the European space programs. ESA has many diverse programs, such as those dedicated to discover more about the earth and the immediate space environment, explore our solar system and the Universe, develop satellite-based technologies and services, and promote European industries (ESA, 2010a).

The ESA-system operates on geographical return. ESA invests in each member state, through industrial contracts for space programs, an amount equivalent to each country's contribution.

Restrictions and limitations can only be justified as part of special industrial policy measures such as geographical distribution to address the situation of deficit countries.

Different restrictions and limitations are applied to Norwegian companies in some of the tender proposals in the ESA procurement system, such as higher grading for Norwegian companies and favoring of Norwegian competence.

4.1.3 The Norwegian Space Centre

The Norwegian Space Centre is a governmental administrative agency, (under the Ministry of Trade and Industry since 2004) with the responsibility to facilitate growth for the Norwegian high-tech industries related to international space activities. The NSC manages the Norwegian membership in ESA, guiding ESA contracts strategically and promoting the development, co-ordination and evaluation of national space activities such as space research and Norwegian space related industry. NSC states that by allocating funds for ESA contracts, they contribute to the development of space activity for the Norwegian space industry (Amundsen & Eriksen, 2010, p. 5).

In the following chapter five, the case companies are presented with a description and discussion of the empirical material, in relations to the theoretical framework as described in chapter two.

5 Case Companies

The thesis selected five companies to examine in relation to space activities as described in chapter 3. Core personnel available for participating in the interviews, experience with this field, and involvement in ESA contracts, limited the number of possible respondents. Since space is considered to be a small part of each firm`s business, each firm`s selected their top management to be the best representative for participating.

The following describes the selected case companies and their core business areas. A more comprehensive table of all companies, respondents position, names and date of the conducted interviews is available in appendix 1. In the case description, I will only refer to the respondent’s surname.

1) Norspace
2) Eidel
3) Kongsberg Defence & Aerospace
4) Gamma Medica
5) Nammo Raufoss

ESA has awarded contracts for the Ariane 5 rocket to some of the case companies. These companies have built a long term relationships with ESA through the stable delivery of equipment for the Ariane 5 rocket from the start (Ariane 5 rocket was launch for the first time in 1997). One of the case companies is involved with the definition stage for its successor, the Ariane 6, which is scheduled to enter into service in the 2020s. Today, several of the case companies have both an ESA contract and National funding or just an ESA contract. Nevertheless, in the past every case company has had national funding or an ESA contract.

5.1 Norspace

Norspace AS is located in Horten about 90 km from Oslo. The company produces electronic equipment and components for the international space industry, specializing in analogue signal processing equipment for satellites and launchers. The firm claims to be a world leader in the area of surface acoustic wave (SAW) technology and it has a long heritage of producing payload equipment (on-board electronic products) for satellites. Established in 2003, Norspace continue with product development and manufacturing after the closure of AME Space and Alcatel Space Norway, which first established space activities in 1984. Today there are around 90 employees in the firm, of which seven or eight hold PhDs, indicating the need for an increased amount of higher education percentage in the space business. The firm has operated for more than 25 years (since 1984) in the space market and has supplied equipment to over 140 satellites. Moreover, in 2009, they had equipment on 130 satellites in orbit, indicating long term experience and trust in this market, demonstrating a quality mark. Norspace has delivered products for many international satellite programs: for example, they have supplied equipment to ESA for Galileo, Meteosat and Envisat satellites.

Norspace is the only company in Norway that is a pure space company, operating in a niche market and solely manufacturing space products. The company is usually a sub contractor for a prime (satellite manufacture) or a contractor for a sub contractor (box supplier) to a prime. Sometimes they collaborate and deliver components to their competitors. Norspace sells their products nearly all over the world; therefore, it is important to understand the policy guidelines and framework that affects these sales. Mr. Andreassen says they pay attention to policy, because it affects how they invest in complex systems. Therefore, it is important to know which government officials, companies or others to contact about collaboration.

5.1.1 ESA has Contributed with Methods and Structure

Mr. Andreassen points out that “We contribute with solutions and technology, but ESA has given us a large amount in relation to methods, meaning systematic and work [routines], and so on”. Rosenberg (2009, p. 72) claims that transferred technology is more than the replication of a process; it also needs to be adapted.

When a firm complies to quality controls and reviews, they use the standardized ESA structure and methods to ensure quality. These methods have been transferred from ESA and adapted by Norspace. Norspace has gained project experience and non-technical industrial structure in areas like project and financial management, security, and quality systems.

5.1.2 Initial Disadvantages Become Advantages

The Space market is very conservative, changing only things when it has to. Customers demand more than products with high reliability. Proving the products function flawlessly in space is necessary. Mr. Andreassen says, “If your products are without flight time in space, the commercial market will not purchase them”. ESA contracts verify flight heritage of products for the market. Access to ESA and this scarce resource (flight heritage) benefit the firm with first mover advantages as argued by Liebermann & Montgomery (1987).

Norspace often works together with ESA and NCS, and over several years, this user-producer relationship has benefited the firm. They have worked together with ESA for the last 25 years. Moreover, he says that there are some “initial disadvantages, which in the long run become advantages”. Interaction with demanding and knowledgeable actors improves a suppliers innovative and competitive performance, as pointed out by Porter (1990, p. 585), Mowery & Nelson (1999, p. 6). The ESA system is rigid, and very formal. ESA demands have challenged the company, thereby making the structure stronger in the end. Being a demanding customer, ESA has functioned as a sparring partner for Norspace`s evolution and this has made the company better. This is supported by Powell and Grodal (2007, pp. 57-60); those relationships that are dependent develop a greater commitment and a more systematic knowledge sharing.

5.1.3 Capability Development from Utilizing the Firm`s Existing Competence

Norspace is innovating incrementally, by continuously trying to improve their components and boxes. To be innovative you need knowledge of your market, technological expertise, a highly skilled staff of engineers, and the ability to develop further. In other words, good knowledge and employees are not enough; the firm has also to be able to develop. More precisely, it needs to have capabilities present in order to gain new or other capabilities, also called absorptive capacity by Cohen & Levinthal (1990). The firm can acquire such capabilities from an ESA contract.

Utilizing the firm`s existing competence and building capabilities helps to improving their products, which increase the companies capabilities. The firm uses their acquired knowledge to gain new developments, and in doing so gain new capabilities from existing capabilities. The cooperation has been beneficial, especially when Norspace is active and defines their own R&D projects, communicating their needs to ESA and thereby working together to find new projects. They have presented several ideas for development projects that they think are smart to conduct for both parties, and after negotiations, they carried these projects out through an ESA contracts. “Being active towards ESA has proven to be successful strategy for us” as Mr. Andreassen noted. This is in accordance with what Lundvall (1985); Powell & Grodal (2005) argue that the member’s ability to share information and skills are developed through a process of learning by doing and this knowledge comes from established networks (information channels).

Today the firm uses those structure and methods on other products and areas as well. The ESA system is complicated and their structure and methods are comprehensive. To qualifying for ESA contracts, “a product needs more than excellent technology: you also need a high industrial credibility”. Norspace has a history of experience (since 1984, AME) and has proven industrial capability. Customers check papers, and review the company to ensure quality.

5.1.4 Using Technology Developed in the Past on Today’s Products

Norspace still uses many of the products developed in the past today. As Mr. Andreassen noted, “We make money on things today, which we developed many years ago”. He says that he has tried to map which R&D projects lead to products; however, it is difficult to say exactly how development occurs.

Norspace has learned much from ESA projects. Using components (electronic equipment, component and sensors) from ESA projects on other products reduces cost, and as Chandler (1990, p. 24) mentions the typical benefits from scale and scope lead to significant cost reductions. In addition to reusing components, existing technological knowledge is exploited. According to Mr. Andreassen, the firm supplies components to companies that build electronic equipment. They also supply equipment they have assembled to companies that build satellites. Between 75-80 % of the produced equipment, have their components inside. The reuse of components and technology is in a way spilling over internally and outside the firm but would not be regarded as a spill over.

5.1.5 Financial Funding and Stability

The firm develops novel technology, and benefits from financial funding and stability. ESA has funded projects, which has made the development of technology and products possible. In the last eight years, the company has been awarded with 163 contracts with average revenue of 400 million NOK. Typically, a project is financed entirely by ESA or the firm. Alternatively, the financing can be split with 50% funds coming from ESA-NSC and the remainder of the funds coming from Norspace. “Especially projects with 50% funding would probably not happen without the financial support”, which indicates that even partial funding of projects is important to the firm`s development.

ESA contracts have predictable product delivery and the contracts last for many years, and while the company`s other products on the commercial markets have to overcome fluctuations in these markets, the ESA contract secures some stability for the firm. ESA and NSC funding of R&D projects directs money to specific projects, which at the same time affects other projects with benefits such as reduced costs. Long term investments and the reuse of technology (products and components) from ESA contracts developments, help to provide stability in market supply and income.

5.1.6 The Outcome from ESA Contracts

According to Mr. Andreassen, Norspace has gained many benefits from ESA contracts. “The benefits more than out-weigh the costs when you consider the outcome”, and the outcome achieved are increased capabilities, structure, and methods, the reuse of technology, and products stabile income and financial funding. However, it takes a long time to reach the breakeven point. The pre-projects take usually two or three years alone and as Mr. Andreassen notes, space is “long term investment, but worth it in the long run”.

5.2 EIDEL

EIDEL is a small company with 15 employees. Over 47 years ago, former engineers from the Norwegian Defence Research Establishment (Forsvarets forsknings institutt) started this company. The company is located at Eidsvoll in Norway around 70km from Oslo. The company has designed and supplied products and control systems since 1966. The company operates in international markets in the aerospace, military, and space industry.

The company’s space activity originates from their telemetry products: decoders, encoders and solid state recorders, ground infrastructure and telemetry, and tracking and command system TT&C. Production is usually subcontracted; however, they conduct all assembly and testing in house. EIDEL has delivered space equipment to ESA, for example a flight recorder to the Ariane 5 launcher. Mr. Havstein says that the company has had “two major projects for ARTEMIS satellite in 1995”. The project was “worth 5 million NOK for EIDEL”.

5.2.1 Interaction and the Difficulty to Enter the Space Market

Eidel has experienced a successful collaboration in working together on one occasion with an ESA company. On this project, Eidel managed the technical aspects and the other firm conducted all the non technical tasks of the project. ESA contracted the firm directly, and managed all tasks that were non technical. Mr. Havstein said that “paper management on three levels is not us”, meaning that the bureaucratic ESA system has a vast amount of required documentation and this is too demanding for their company size. Eidel is a strong technical company that usually relies on partner companies to handle the non technical aspects of the project.

Eidel is trying to get into the industry but does not have the size. Mr. Havstein notes, “In Norway only two companies earn money from space, Kongsberg and in particular Norspace”. “Usually big companies have the credibility and contracts and most of the Norwegian companies are too small”.

Being first to the market is vital, especially when operating in a niche market. The size of the niche is important, if it is too small, there are no earnings and if it is too large, the big companies get involved and take over.

NSC informed EIDEL that it is hard to get into the space industry, and one reason is that EIDEL`s core business is too close to what the major Prime`s subcontractor's are regarding to be their core business. Primes use existing subcontractor when they need this type of business. Eidel began working with cryptography when no other companies in Norway were interested. One of the reasons was to differentiate Eidel from others companies.

Mr. Havstein mentioned that space projects could be dangerous, because space projects are very interesting. The developed technology may not fulfill customer`s needs. "If there is no need, there is no business" and the commercialization of a product will not succeed.

5.2.2 Gaining More General Knowledge than Technical Aspects

ESA brings in their competence for developing quality. Mr. Havstein says that "ESA`s main concern is that products are robust and that technologies are proven". Eidel contributes with innovative products. ESA does not have the most up-to-date novel technology. To gain new knowledge of novel technology and products, the firm uses other channels than ESA.

It is difficult to measure Mr. Havstein notes "what kind of benefits from an ESA contract that are transferred into a commercial product". Most likely, it is the general knowledge that Eidel has gained from doing space projects.

Eidel believes it is important to have the right knowledge present in the company. Many engineers work for the company, securing skilled labor. One dedicated engineer is working with space projects. Hired because of an ESA project, Mr. Jan Erik Nordal is the only engineer that solely works on space projects. Mr. Nordal says, “There is not much difference between working with space projects and other developments we conducted”.

Due to this contract from ESA, the company has increased its knowledge. When needed there are also a few highly educated employees available for space projects. Solving the needs of customer is the same if it is for space or the commercial market. The technology is the same even though the customer needs may differ.

5.2.3 Space Projects Attract More Applications for Work Positions

When the firm is recruiting, they receive more applications with highly skilled people. Due to the space projects, Eidel has increased the competence in the company. Without those projects, they would have to choose from a lower number of applications with reduced level of competence.

Having the right balance and combination of software and hardware specialists is important to EIDEL. Today, the company has more engineers with software than hardware experience and the proportion is rising. This means that the core competency and capabilities are changing. Skilled labor that has increased their knowledge working on space projects is not only changing competence but also the firm`s core capabilities. The current competences are the possibilities to learn and combined with an ESA contract, the firm might acquire new capabilities.

5.2.4 Developed Products for ESA, Application in Later Commercialization

The Artemis project has generated internal spinoffs. One of them is a developed missile recorder for ESA that was reused for Kawasaki`s supersonic transport aircraft. The company also benefits from an earlier development for the Ariane 5 program. Developing a recorder for the rocket has provided confidence and credibility. The missile system that they have delivered in the past, has increased the firms confidence and strengthened Eidel`s reputation. They have also been reusing the developed recorder for Ariane 5, as a standard box in other products for the past 15 years now.

The developed products for an ESA contract play a large role in later commercialization. This shows that the reuse of technology and products generate benefits many years later. Eidel benefits from increased reputation and credibility that attracts customers and the reuse of products saves costs, increases their profit and provides stability. Mr. Havstein points out that they "probably have reused 90% of the acquired knowledge". Nevertheless, the amount varies in each commercial product. Today Eidel is more selective and not interested in a contract just because they get national funding. The contract has to benefit not just their space products, "but it has also to be useful for our commercial products".

5.2.5 The Reuse of Technology and Products Secures Stability

Currently EIDEL has no ESA contract: nevertheless, it has stability from the technologies and products they have developed in the past. The product has proven its quality's through flight heritage. Mr. Havstein says, "no one questions the reliability after a product has worked in space". Eidel believes it is important to reuse the technology in form of components, hardware and software. "We use what we have time and again, making new things just for the sake of being best is pointless", which again indicates stability.

Eidel benefits from increased reputation and credibility, which attracts customers. They also reuse developed products over many years, which saves costs, increasing their profit and stability.

Telemetry and crypto are areas the company specializes in, and "maybe there is some import, but no other companies in this area exist today in Norway". Eidel prefers to invest in areas, where they have few competitors in Norway. The company's core business is in development and not production. Eidel sees itself as a development supplier for the next stage. This core business is a competitive advantage. Zook & Allen (2010, p. 14) argue that understanding and focusing on the company's core business generates sustained and profitable growth.

5.2.6 Companies are Investing to Gain Synergies

Eidel has invested five million NOK in space activities for the last five years and had no return of investment. They are investing money to gain synergies; however, after five years Eidel has lost five million NOK. Moreover, they are unsure if there are any synergies worth their investments. Mr. Havstein has noted that it is "difficult, and that is why many companies hesitate to participate in space activities".

For small business, it is difficult to finance projects. Mr. Havstein points out "when the company must finance half of a project, it is easy to overlook a space project and focus on commercial products". The time perspective combined with financial burdens makes it complicated for small businesses to compete to participation in ESA projects.

"Everything in space takes a long time, and you cannot succeed without the support from NSC". To qualify for ESA it is important to have good staff and credibility, and "It takes a long time before synergies from projects are ready to use".

5.3 Kongsberg Defence & Aerospace

Kongsberg Defence & Aerospace (KDA) is located about 90km from Oslo at Kongsberg in Norway, and is part of the KONGSBERG Corporation. Kongsberg has 5423 employees worldwide, and a turnover of 13.8 billion in 2009. The corporation supplies high technology systems for the maritime, oil and gas, defense, and aerospace markets. KDA supplies advanced composites, engineering products such as communication solutions, command and control systems for aerospace and missiles. They also work in designing, and developing complex space subsystems for satellites and launchers. Mr. Fiskum said that the company`s space activities are derived from missile production, in the eighties. Space evolved to an independent department in the nineties and the company developed a booster attachment and release mechanism for Ariane 5. Kongsberg has also provided equipment for Earth observation satellites such as ENVISAT and for navigation satellites (Galileio).

5.3.1 Interaction, Network and Policy`s Important Functions

Working with ESA fills many important functions. It helps to build networks with tender partners and competition. Today, KDA is collaborating with ESA, NSC, and the French Centre National d`Etudes Spatiales (CNES). KDA works with partners in each ESA contract financing some of their space projects themselves or with support from ESA and NSC.

Mr. Fiskum mentions that being awarded an ESA contract leads to more benefits than just credibility, good solutions, or the special incentives from low return rate. Some benefits are intangible, in the Norwegian space industry ESA and NSC are critical actors. For KDA it is a strategic reflection to show their importance for space projects and industrial development. These organizations are public funded, so governments have to see what important roles they play. Proving what they contribute is essential; otherwise, reduced funding is likely. Since reduced funding of space activity affects testing of the industries products, this funding is vital for companies to enter the commercial market.

Mr. Fiskum also discussed flight heritage, since space is a conservative market that only accepts changes when it has to. Flight heritage means products have flown in space (in situ) and proved to function appropriately. ESA launches satellites into orbit, some of which contain smaller non-operational satellites, which serve to test certain features and equipment.

Commercial actors are not interested in products that have no flight heritage. It is “common that the commercial actors demand 3 years of flight heritage from a product, due to costs and especially insurance costs”.

These intangible advantages for example the in situ testing of equipment could vanish without ESA conducting these tests and KDA would not have a satellite project. KDA is aware of that they need ESA and NSC and “these organizations needs the support from KDA as well it is a team effort you might say”. As noted by Mr. Fiskum it is unthinkable for KDA to conduct this testing alone. ESA makes projects and thereby new products possible.

5.3.2 Space Projects Have a Higher Demand for Reliability

ESA contracts have many reviews such as quality reviews and extensive testing reviews. The required documentation is substantial and time consuming. KDA acknowledges the transfer of knowledge from ESA to be a significant benefit. ESA has required (through ESA contracts) that KDA learned to use another type of logic, stricter requirements, and a new methodology. The company has adapted over the years to the level of awareness of quality and testing.

ESA, NSC and the Primes have no direct transfer of expertise to KDA. This is mainly because if they interfere in the development of the project, they also assume the responsibility. Moreover, they do not want to take over the responsibility. Hence, they are purely commenting and discussing the project.

It is important to remember is that ESA has its own priorities, such as component independency from the United States, and they may recommend companies to develop a certain technology to achieve this, even if there is no commercial market there for the company in the future.

5.3.3 Capability Developed Into Corporate Culture on Multi Disciplinary Subjects

The products developed require different types of technology and multidisciplinary products are complex in terms of advanced technology. KDA and the Missile system department possess a broad understanding and are good at managing complex systems.KDA competes in a multi-disciplinary niche. It has a corporate culture on multi-disciplinary subjects. Therefore, this complex system is not only a systematic part, but also a capability of KDA.

The capability leis in “how things are done here”, Mr. Fiskum mentions they learned this when working on space projects and it is now a part of their toolbox that they use when working on other projects. KDA can conduct a comprehensive analyze, because someone in the company has the needed expertise. Mr. Fiskum says that this is a heavily used capability; moreover, it underlines that the capabilities of the organization is the combined management’s skills, which according to Chandler (1990, p. 36) is the most valuable.

ESA is system engineering at its best as Mr. Fiskum says, “It is fun for good engineers to work with space because they work on tough challenges together with other good engineers”. Since space requires more knowledge, a higher percentage of Master Engineers work on space projects on a regular basis. Exchanging personnel between space and missile spreads more than knowledge and competence. The employees work on different projects within the core business, thereby increasing individual competence and the firm’s core capability. KDA is building “brick on brick”, one step at a time using recruitment plans, strategic planning, and long term commitment. KDA is keeping up to date with the technology by using a systematic approach. Employees update themselves as a natural part of their work. When needed, the firm buys technology or competence in fields outside the core business.

5.3.4 ESA Contracts Generated Spin Offs and Spin Inns

According to Mr. Fiskum, ESA contracts generated spin offs and spin inns. Spin off technologies developed for space (through ESA contracts) are used today in missiles and in turn, spin inn from missile technology is applied to space technology. KDA has just a few products and is continuously working on minor product improvements. This means that the firm has internal exchange of knowledge, and is reusing technology and products.

ESA contracts have made it necessary for KDA to attract new employees. Furthermore, it was necessary to establish new cooperation. For example, KDA worked on the development of an ESA environmental satellite. Due to this ESA contract, the firm collaborated with the Norwegian Defence Research Establishment and the Foundation for Scientific and industrial Research (SINTF).

5.3.5 Affecting Other Projects Extending Beyond the Reuse of Technology

According to Mr. Fiskum, the entire company benefits from the methodic systematic competency required by ESA, and ESA contracts influence the firm's use of capabilities, more than the technology aspects. Compared to other departments, the space department organizes their engineers in small, multi disciplinary and dynamic teams, who work closely with the customers and in all phases of the product cycle. Mr. Fiskum says they have a "good relationship with ESA and NSC".

The company sees ESA as more than just profits from a contract. ESA`s testing and verification enable technology development and flight heritage of KDA products. The firm benefits are reduced costs, increased knowledge, and predictability in production and income.

Other important ESA benefits are financial funding of R&D and the reuse of technology and competency. For example, KDA has developed solar panels for ESA with a light composite material. KDA has reused the technology and products in the aircraft industry.

ESA contracts have generated internal benefits to KDA like stabile activity, confirming Chandler (1990, p. 42) claims that companies that master the needed specialized technical and organizational skills to commercialize a product understand the complexities and importance of long-term performance. According to NSC, KDA has provided services and equipment for over 500 million since the start of the program. Mr. Fiskum points out that "Contracts for the launchers are generally important for us because it is an activity that is stable" (NSC, 2009).

5.4 Gamma Medica

According to the General Manager Mr. Mæhlum, Gamma Medica, Inc. (Gamma) does not produce but sell technology to their mother company, which is a large foreign company. They conduct all production and sales while Gamma is a pure R&D department that is operating solely with R&D. Gamma is located at Fornebu, just outside Oslo. The firm develops electronic systems and components for detection of gamma and X-rays. Their radiation detector systems are consisting of electronic components connected to sensors. Gamma does not develop sensors but the integrated technology, such as application specific integrated circuit (ASIC) chips, detector modules and software systems. The firm has developed ASIC chips since 1992, for the worldwide commercial and scientific market, the ASIC chips have been used booth in scientific and commercial satellites. The company's main revenue is on the medical market (clinics and laboratories) while revenue from space activities is just representing a small part. The firm possesses a highly skilled international environment with currently around 11 employees, two hold Doctoral degrees in physics, and the other employees are for the most Master Engineers. The company has close cooperation with doctors and clinics.

According to Mr. Mæhlum, the company is "solving specified customer needs" for NASA (National Aeronautics and Space Administration) and JAXA (Japan Aerospace Exploration Agency). Gamma has two active space projects per year, most with JAXA and some with NASA. Generally, the company only works with ESA when they are specifically contacted by ESA for a particular product. They also deliver products to a Portuguese company that deals with ESA. Currently they have no contract with ESA, but they had a big contract many years ago.

5.4.1 Complicated Process and User-Producer Relationship

The company's experience with ESA, according to Mr. Mæhlum is that it is a very complicated process, and the priorities of ESA`s bureaucratic system is wrong in the sense of that ESA should care more about needs and costs. The customer concerns should mainly be about the quality and the price.

ESA has been the toughest customers for Gamma and the size of the contract illustrates it best. There are significant differences between an ESA contract compared to NASA and JAXA contacts. ESA wants a detailed control of the project, while NASA and JAXA give the firm more freedom to conduct their projects.

The differences between these contracts is in how ESA has made the requirements and specifications; "from ESA they are mildly overwhelming". The last ESA project had limited success, as the scope was too large with many specifications. Many of the specifications and requirements were in the end neither to the benefit for ESA or Gamma. This makes it difficult to make a profit; "ESA should have split up the project and limited the requirements". The contract was too big for the company size and Gamma had to subcontract to other companies.

5.4.2 Interests and Requirements Differ Extreme VS Minimum

Mr. Mæhlum points out that their customers can fine tune Gamma `s products and because customers have more time, better equipment and access to qualified labor, so they can gradual improve the product performance. A rocket 'just' has to work after specific requirements. Gamma `s customer work in the field of science, and besides minimum requirements the limits are unclear in this field.

The company delivers products that meet minimum required specifications. Although, they know that their products can achieve higher output, they do not pursue it because the market they operate within uses minimum requirements. The size of the company may not support the cost or the improved performance does not generate enough profit. Their niche market includes covering a customer's need for products that just meet minimum required specifications.

This feature in Gamma `s core business, is in conflict with the needs of ESA, which requires products with extreme specifications and documentation. The difference in Gamma `s requirements philosophy are a part of Gamma `s core business attitude, since ESA has strict rigid view and NASA and JAXA has a more practical view as Mr. Mæhlum noted.

5.4.3 Intellectual Property an Obstacle for Collaboration

ESA`s attitude towards intellectual property (IP) does not work for Gamma, because ESA requires access to detailed solutions such as design and engineering. For Gamma, the IP has to stay with the company otherwise, they will not collaborate with ESA. Mr. Mæhlum says that it "would mean ESA could go elsewhere with their business secrets". NASA and JAXA are only interested in how the product works as long as the product meets all requirements, and do not need details about the technology like ESA does. This is one reason why the firm works often with NASA and in particular with JAXA.

Gamma has devoted about half of their time for internal developments. It was not necessary to attract new knowledge, technology or employees because of ESA projects.

5.4.4 Overlap between Space and Medical Equipment

According to Mr. Mæhlum, space projects are used to develop new technologies, “because they are better paid and have a long term perspective”. “The mother company has no space activity and is happy that we are dealing with this because it increases the revenue in Norway”. This could indicate that Gamma is seeking a stable income and market.

The space market is conservative and has a long timeline. The firm gains new knowledge through suppliers, participating at conference and collaborating with customers.

There is a considerable overlap between space and medical equipment, “boxes that are used in clinics are almost identical to those used for example in JAXA satellites”.

5.4.5 ESA Contracts Have Been Disappointing

For Gamma being attractive and qualifying for ESA contracts has proven to be difficult. Considering that, the firm delivers to NASA and JAXA similar associations should make them attractive towards ESA.

The contracts with ESA have been limited and to some extent disappointing. However, the company has gained a better understanding of its own technology, benefiting internally with increased knowledge of their own products. The firm knows more about their technological strengths and weaknesses, meaning increased technology awareness. Although it is difficult to measure these kinds of benefits, when Gamma learns something from a space project, they can transfer the technology and process to the commercial part of the firm.

Gamma had an important ESA contract, with funding from ESA and NSC for an R&D project however after the contract was completed it did not contributed significant for the company. Mr. Mæhlum mentions that, “we did invest a lot of energy on this, nevertheless it has not affected other projects significantly in the firm”. This means that Gamma has benefited from an ESA contract at the time; however, with limited synergies and short timeline the benefits are small.

It might be that Gamma has evolved with support from space organization other than ESA, but has acquired similar benefits like the other case companies. It has benefits like those companies collaborating with ESA such as stability, reuse of technology and increased knowledge. Reusing products can give stability and the reuse of technology can increase knowledge and capabilities.

5.5 Nammo Raufoss

Nammo Raufoss AS (Nammo) is located at Raufoss in Norway about 120 km from Oslo. In 1896, Raufoss Ammunition Factory established a production facility at Raufoss. The industrial area has evolved into an Industry park with more than 30 companies employing 3000 workers. Nammo is one of the largest companies in Nammo with 650 employees. Since the early 1960`s Nammo has developed and produced advanced rocket motors within the niche of tactical propulsion technology. Rocket motors are designed, tested and produced for different missiles such as rocket boosters, naval missiles and short range air to air missiles for example Sidewinder AIM-9L (Air to Air Missile) and Penguin MK2 & MK3 Motors (Anti Ship Missiles). Ammunition, special artillery ammunition and rocket motors are developed and produced for the defense market, mainly for NATO (North Atlantic Treaty Organization). The missile production division manufactures propulsion systems and warheads for missiles and small rocket motors for space application. Nammo`s space activity started in the 1990`s with R&D for the Ariane 5 rocket. They produce separation boosters (FE), acceleration boosters (FA) and safe & arm mechanisms (BSA) for the French prime contractor Astrium.

According to the Program Director Mrs.Turi Røyne Valle, Nammo supplies for each launch of the Ariane 5 rocket two main boosters, and for the safe release of these main boosters, 16 separation boosters and occasionally four additional acceleration boosters to provide extra thrust. Currently she says, “There are six to seven launches a year”. Nammo produce military rockets as well and space activity is organized under the rocket division. Nammo`s employs many engineers, quite a few of which hold higher degrees. The firm uses a matrixes organization and the education level of their workforce does not differ from the other departments in the firm. Space applications are a small part of production for Nammo Ms. Røynne Valle says that, “if we look at our rocket division space is around 10% in recent years” and the firm is slowly increasing the share in the division.

Nammo delivers equipment to the Ariane 5 and other space projects through an Italian company and they now deliver to the launch site in Brazil through a major European contractor. Nammo has funding from ESA for the Ariane 5 and from NCS for the hybrid technology where they have developed a student hybrid sounding rocket for the Norwegian Centre for Space-related Education.
Nammo has had a few ESA projects, and recently worked on a development project (hybrid engines for rockets) in cooperation with Lockheed Martin Corporation in the USA.

5.5.1 Easy to Contact and to Cooperate

Nammo has a good experience working with ESA and in general, Mrs. Røyne Valle says, “that ESA is very easy to contact and to cooperate with”. We have regular meetings and face to face contacts with ESA, their employees come to Norway for project developments, discussions, and updates. Suppliers and customers working together, in a region or in other forms of networks, are according to Mowery & Nelson (1999, p. 6), reinforcing their capabilities throughout this interaction.

The organization in Nammo uses an internal system with regular meetings to exchange information about what the others in the company are doing. From each development project, Nammo transfers things learned throughout the experience such as “how we did it there and how can we apply it to another product”, because they want to increase their core business.

5.5.2 Good Interaction in a User-Producer Relationship Leads to Possibilities

Because of the ESA contract for Ariane 5, Centre National d`Etudes Spatiales visits Nammo occasionally. Over the years, the firm has established good contact with CNES. During one of the visits to Nammo, they were informed about the hybrid technology project with Lockheed Martin Corporation in the USA. Recently ESA had shown interested in this hybrid technology, and because ESA cooperates on other projects with CNES, ESA gained knowledge of Nammo`s hybrid technology project. ESA contacted Nammo to receive some more information about the status of the project. ESA had not contacted the company in the past even though they knew about the hybrid technology project, since ESA believed that International Traffic in Arms Regulations (ITAR) restricted this technology.

Nammo was not under ITAR restrictions, because the hybrid engine technology was theirs and they only received specification such as diameters from the Lockheed Martin Corporation. ESA then invited Nammo into a hybrid-rocket project and this year Nammo is currently involved in phase 2 and negotiating about the third phase of this project. Nammo will never be a prime contractor although a prime contractor will be dictated by ESA to use Nammo on the parts of the contract.

According to Mrs. Røyne Valle, the firm has to “be responsive to become attractive for ESA” and Nammo is active towards ESA, but it is also very important that the company has the right employees, experience and knowledge to qualify for contracts. From the ESA contracts, Nammo has developed knowledge and technology; however, they need more engineers working with development. Nammo produces everything in Norway, except the activator that is bought from a French firm. Hiring more personnel that are skilled should increase their knowledge base, which can be used for other projects and is therefore a benefit from an ESA contract.

5.5.3 Long Experience and Little Competition

Nammo has a competitive advantage in the space industry market, because there are not many companies in the world that produces rocket engines. There are about three to four producers in Europe and ESA wants competition so here the company has an advantage. If ESA needs medium to small rocket engines, they come to Nammo because they know that it is their core business and are highly skilled with extensive 40 years experience in casting such motors. Since Nammo is Norwegian company, tender proposals get higher grading as well.

5.5.4 Developing New Skills

They view contracts for collaboration as more than buying a technology or expertise; they are gaining experience, which they can reuse afterwards. Nammo gains new skills when they are working on a project, because different personnel and technologies are involved in development projects. However, on the quality side there are the same engineers planning and designing the project. Nammo exchanges expertise and technology both internally and externally. Mrs. Røyne Valle mentions, when “we cooperate with others and even we can’t take the technology from someone else we still see the relationship”, noting that there is more to gain from collaboration than just technical knowledge. By cooperating with others, the company has also increased experience within the same technology, which benefits Nammo in other products.

5.5.5 All about the Future Possibilities

ESA contracts are not big business but have long term impact for Nammo. While ESA development contracts do not earn the firm a large portion of its income, future production might prove to be a good source of income. In regards to the income provided by ESA contracts Mrs. Røyne Valle claims, “It is small amount but it is a very nice constant basis and because other markets fluctuate constantly, this saved us in the early 90's.” This stabile income is gained from their technology development for ESA and the company benefits by using knowledge gained in other places in Nammo. According to Lundvall (1985, p. 27), it is a virtuous circle with cumulative consequences that both users and producers are learning-by-interacting and such mechanisms result in stability.

ESA contracts financially support R&D, maintaining and securing a continually “technological development because if they stop developing their quickly out of the market” as noted by Mrs. Røyne Valle. The contracts make it possible to keep the R&D department at a constant level; otherwise, they would have to reduce the number of employees working there. The company’s benefits financially in short terms by having an R&D department and in the long term it increases the company’s knowledge. In the rocket division, every project is an advantage that can sustain their development and help to keep knowledge and experience in the company. This it is not specific to space but for the whole division in Nammo.

5.5.6 Focus on Core Business

Nammo has acquired knowledge that has resulted in a new product for example composite materials that are now being used for producing plastic gas containers, and in other products in the firm. Nammo had the idea to use the developed composite material for gas containers. However, Nammo wanted to focus on their core business and engage a collaboration partner to manage the gas containers. This support`s Henderson and Cockburn (1996) view of substantial spillover between firms in the industry, and that spillovers from R&D play a key role as noted by (Spence, 1984; Dasgupta & Stiglitz, 1980), although, the impact is difficult to estimate.

An item suggested, but not carried out yet, is to use the production methods that are used for ESA projects on other products. It is about quality, “ESA is so large that they have proven systems of how things should be managed in order to maintain the quality and this could probably be transferred to other places as well” as Mrs. Røyne Valle points out. The company has learned quality from ESA and even they have developed the production process themselves they are benefiting from reusing technology and products.

ESA contracts have had a long term impact for Nammo, and have allowed the company to gain technological development, new skills, and experience. The contracts have also encouraged the reuse of technology and products, and have provided a good source of stability in the market and constant basis of income.

In the thesis, next chapter the theoretical framework is applied on the empirical material, this helps to investigate and understand what benefits occur from ESA contracts and how these benefits occur.

6 Analyze

This chapter explores ESA contracts in relation to the developed framework, before applying the theoretical framework on the case study findings, examining what benefits and how they have occurred. In addition, the differences in company size and policy implications are discussed. Presenting in table one an overview of all case companies benefits from ESA contracts.

6.1.1 ESA Contracts in Relation to the Theoretical Framework

ESA contracts are awarded on the basis of the firm`s credibility, to ensure the company can carry out the development today but more important tomorrow and in the future. Companies have to prove their durability as well as their technological expertise in a conservative market. It is time consuming but necessary to establish a strong user-producer relationship, benefiting only if the company has the capability to adapt to the system and is able to utilize the possibilities in an ESA contract. However, rewarding companies with an ESA contract, long term investments are needed.

6.1.2 Technology Transfer

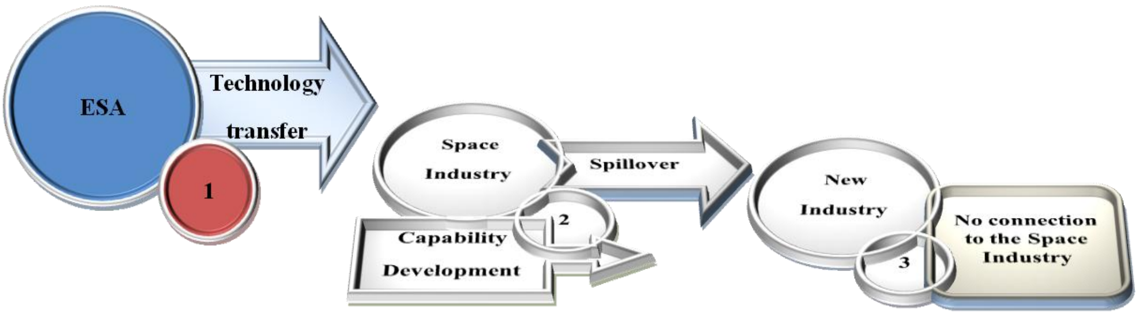


Figure 9 Theoretical Framework Technology Transfer

When a firm has been awarded an ESA contract, it receives financial support to develop or supply technology or a product. This financial transfer is obvious and direct however, there are indirect transfers because of the ESA requirements. For example, for quality, ESA or the ESA-prime will continually oversee the process of the development with many different reviews such as quality, testing and verification.

The design, validity, testing and documentation requirements are evidence of indirect technology transfer, using transferred knowledge like developed methods and standards by ESA in the space industry. The case companies might use the developed methods and standards for example ensuring good quality, as effective tools and are therefore reusing them in their commercial non space projects as well.

Because requirements in the contract binds companies to use ESA approved specific methods and processes, an indirect transfer occurs, and technology transferred from a specific market such as space are used to adapt, develop, or improve existing processes or products in completely different market sectors is also according to Fletcher (2009, p. 4) technology transfer.

Technology transfer can benefit the case companies with improved products and process, by replicating ESA methods and process, and adapting to their standardization. The existing knowledge in each of the companies affects how successful the transfer would be furthermore, the interaction in a user-producer relationship is also important.

ESA awards contracts to companies they trust and have a history of stable relationships. For producers of complex product innovations that deliver on a regular basis to a specific user such as ESA, the producer’s trustworthiness is an important and competitive factor. ESA contracts are not off the shelf products, so the complexity of technology, products, and other factors means that as a user ESA has only the producer’s guarantee that the product will perform according to the required specifications. It is obviously important for ESA, but the producer`s desire to be regarded as trustworthy also indicates responsibility. The producer's trustworthiness will attract old and new users, especially if it is proven over a long term.

In a user-producer relationship, the exchange of information and product innovations promotes a stable relationship. Several factors such as mutual trust and the high costs for establishing new user-producer relationships tend to increase stability. The user-producer interaction is affected by user needs and technical opportunities. These aspects favor and reinforce the stability in the already established user-producer relationship, rather than allowing the existence of new relationships to grow strong.

The case companies supply technology and products to ESA, which are specialized and expensive, therefore close cooperation is required in this user-producer relationship, where the user wants to monitor the producer closely. In a weak relationship, returns are marginal even with an increase of contracts according to Lundvall (1985, p. 28). Establishing and developing a solid user-producer relationship takes a long time, because it is build up on trust and trustworthiness has to be proven.

Since there are differences between the case companies in the evaluation reports of the NCS, the user-producer relationship could vary between them.

ESA has transferred competence, such as methods, to companies and those companies have to use their absorptive capacity to increase the firm's competence, and in the long term their core capabilities.

The transfer of methods and knowledge from ESA to company's increases competence and since firms space activities are closely related to their core business, it also increases their core business. Because companies differ from each other, utilizing technology transfer could be challenging for the industry. The strength of the user-producer relationship might also determine the return of investments. Technology transfer requires an organization and employees to absorb new skills (competence) that later become routines (capabilities).

ESA contracts have contributed with financial funding to the firm's and have increased the company's core competence, by securing and maintained existing capabilities and providing new capabilities. Firms have improved their commercial products characteristics like reliability and performance, because of knowledge transfer such as structure and work methods, from working on an ESA contract. This has benefited some of the companies with cost savings and thereby increased their income.

6.1.3 Capability Development

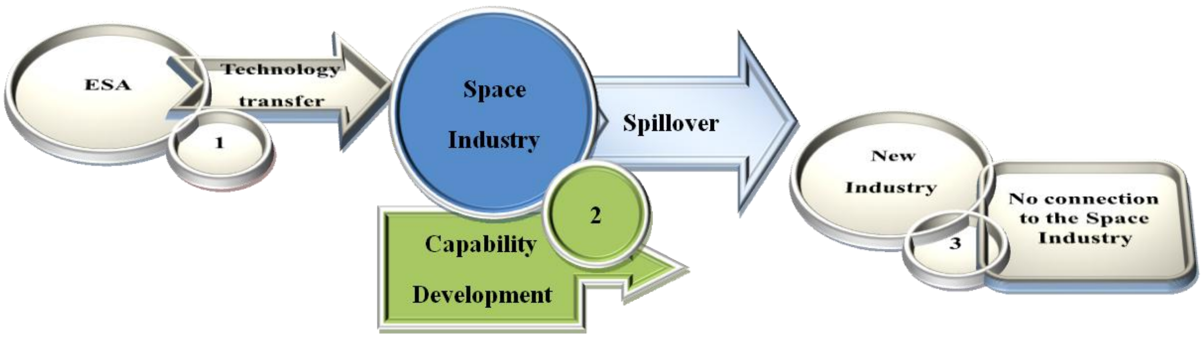


Figure 10 Theoretical Framework, Capability Development

Norway's participation in ESA and the collaboration between ESA and Norwegian companies through ESA contracts utilizes existing capabilities in the firms, but it also allows companies to increase their competence and learn by doing projects. In other words, they benefit from Norway's participation in ESA, by using their capabilities to develop and gain new capabilities that are used elsewhere in the company and thereby are a part of the industrial growth.

ESA contracts are comprehensive, binding the involved companies to ESA standards, and therefore companies need competence to deal with more aspects than technological innovations. The management has to use the firm's capabilities, which require established structures for utilizing the knowledge of what competence the firm has and what is needed in order to absorb, to replicate and develop innovations.

The evolution of a firm's core business from technologies or products emphases the importance of stability to the firm`s core capability. Because commercial markets are exposed to fluctuations, in contrast to the stability of for example the ESA market. This stability can be from ESA contracts, such as funding from ESA or NCS, and it secures income from non fluctuating markets.

First mover companies have advantages from economies of scale and scope (reuse of technology and products). Increased experience and capabilities and the use of the established infrastructure, such as the adaption of ESA methods save costs. Access to ESA facilities (flight heritage) help to preempt scarce assets.

First mover advantages may be enforced because space activities are very expensive and companies need long time to become established, and these advantages can ensure the first mover sustainability.

Managing capabilities is challenging, and establishing a good management is not easy, especially for the first movers, but is important in order to gain economies of scale. All case companies started their business many years ago and could have first mover advantages. If the case companies able to utilize being a first mover, they should have earned positive profits and could have a dominating position in market today.

Working on ESA contracts have increased the firm's credibility, which is important for their commercial products. It makes the companies more attractive for new, highly skilled, employees that are necessary for space activities. The firms have gained new knowledge about their own products and are developing new technology because of knowledge acquired from space project. This increases the competence, which benefits the firm as a whole.

The products have a longer life cycle, and they are a significant contribution for the firm in form of stability in market and income. Commercial products compete on fluctuating markets, while the ESA market has provided stability. This secures vital income and for some companies it has provided sustainability, saving them from bankruptcy, in the 1990's.

Empirical findings have shown that companies have benefited from economies of scale and scope, by reusing developed technology, equipment, and products from space projects on their commercial products. However, the space activities production volume is significant lower than the commercial production, and considered only as a small activity in each company.

6.1.4 Spillover

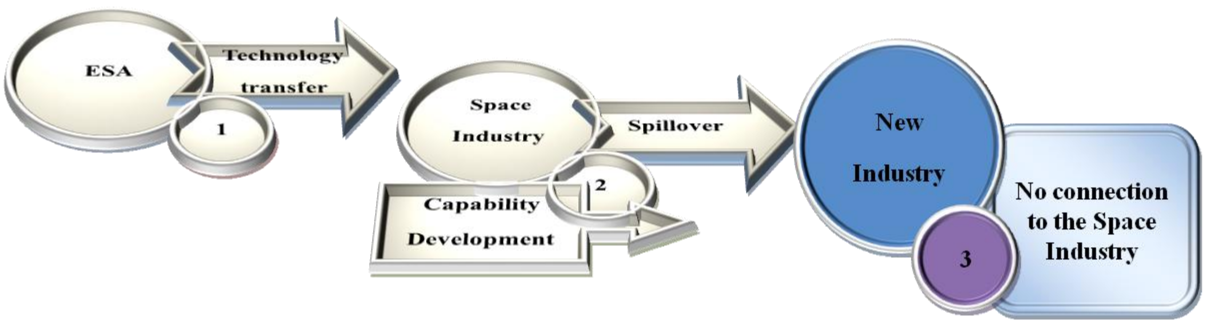


Figure 11 Theoretical Framework, Spillover

ESA contracts can lead to spillover internally by reusing technology, and externally by diffusion of knowledge. External spillover should ideally be to a new company or sector that has no ties to the origin of the developed technology. The ESA report BR-280 states that ESA uses technology brokers and incubators to stimulate more external spillover from space to non-space sectors and also assist in the transfer process. This diffusion could establish new markets for the company that has developed the technology but this would merely be an organizational matter and not an external spillover.

It is natural to assume that case companies consider internal spillover to be an advantage and that external spillover could indicate a threat of competition. Even if the external spillover would be used in a very different sector and on different products or process, it could still lead to new entries in their established markets.

ESA contracts have lead to internal spillover in the form of reuse of technology and equipment on other commercial products. The internal spillover represents significant benefits for the case companies, even if the spillover contribution might be difficult to measure and evaluate.

There are only few cases of external spillovers, and these are limited organizational aspects rather than the real spillovers to other industries that the government seeks, due to the way that the case companies have ownership in the spinoffs.

There are differences among what benefits each company has realized. All the case companies started early, began participating in ESA programs at about the same time, and should thereby have experienced first mover advantages. These first mover companies however, must also have the capability to absorb technology transfer, and the commitment to build strong user-producer relationships.

This might indicate that the size and complexity of ESA contracts requires more than technological knowledge. It also might require a certain size of a firm to sustain and conduct an ESA project and to benefit on commercialization afterwards. The size of the case companies varies, and the large firms have obtained a greater success that the small firms. The firms have done so by learning by doing, evolving their user- producer relationship, and thereby increasing not only competence but also developing their capabilities, and gaining new capabilities along the way.

The case companies are clear that they have benefited or are still benefiting from ESA contracts today. Some of the companies also acknowledge that spillover benefits could be increased if they invested more energy into these areas. Mainly this is not a priority because of timeline and financial matters. For smaller firms, this is often an economical choice, where they face difficulties with the long time before return of investments.

6.1.5 Policy Implications

Spinoffs and spillovers to other industrial sectors findings are quite limited in this thesis, and indicate that more effort by the companies and a different public incentive is required to accomplish this. In addition, there is a conflict of interests between the public and the firms. Companies receive public funding and the public wants something in return for their investments.

Since most companies are not interested in diffusion of their developments, the government`s goal to achieve external spillovers is challenged. Strong incentives towards using the existing user producer relationship can help the realization of the firm’s own projects. This has proven to be a successful investment and advantage for at least one company and the firm is less concerned about the diffusion of their technology because they still have first mover advantages in their niche market. Rather than selling the technology and generating start ups through a technology broker or incubator, the public could utilize the companies own capabilities and potential to stimulate more internal spillover.

The increase can lead to applications to a wider range of technology, and in doing so becomes distance from the firm's core business. As such, the developments in other industries are not a threat to the core companies, which can more easily lead to diffusion of the development and thereby generate external spillover.

To accomplish more external spinoffs and spillover the government has to consider altering the means of how the system works today.

6.2 The Case Companies have Gained Benefits from ESA Contracts

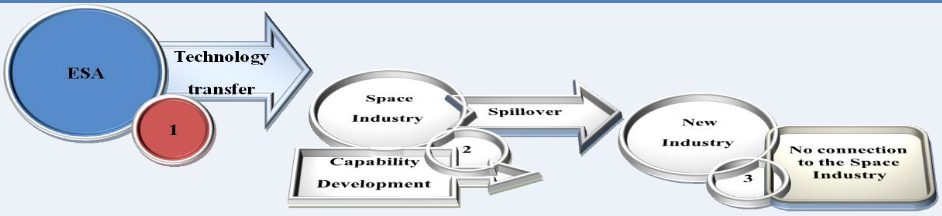
Technology transfer has contributed with funding, establishing networks, general knowledge in the form of methods, standardizations, different reviews to ensure the technology and product function according to strict requirements and access to the scare recourse of testing equipment in space, to provide the companies with flight heritage.

Conducting space projects has benefited the firm's reputation, confidence and credibility. Learning by doing is providing experience, insight and expertise to the companies that have acquiring knowledge and develop new capabilities. Some firms have evolved organizational structure and corporate culture while others have acquired new skills in process and on materials.

Spillover has improved technology and products performance and reliability. In addition, the firms benefit with economies of scale and scope by reusing knowledge, technology and products for commercialization.

Table 2 presents an overview for each case company`s technology transfer, capability development and spillover gained from ESA participation.

6.3 Empirical Findings

Technology transfer **Case company**	
Norspace	• ESA work-methods, standardization, review • Verification of flight heritage • Funding and long time investments and access to ESA network • Stability, predictability in delivery
Eidel	• Verification of flight heritage • General knowledge
KDA	• Verification of flight heritage • Access to equipment testing in space • Control reviews, Quality reviews, Testing reviews • Funding and access to Network
Gamma Medica	• Funding
Nammo	• Quality standardization • Funding and access to network
Capability development **Case company**	
Norspace	• Project experience, management, quality system • Organizational structure • Extended Technological expertise developed broader and deeper • Developing new capabilities, from learning by doing • Acquiring knowledge for new products • Reusing components
Eidel	• Reputation improvement • Product performance developing confidence, increased credibility
KDA	• Using new type of logic, a new methodology, stricter requirements

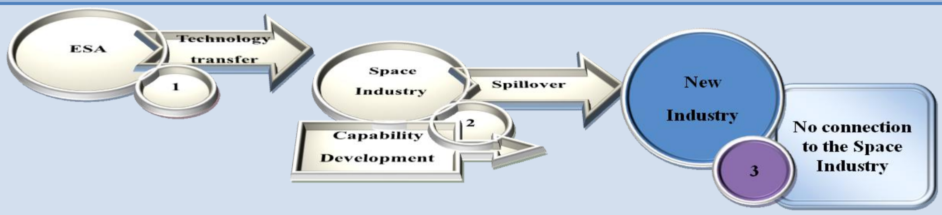
	• Developed new capabilities, system engineering, material • New knowledge light composite material • Projects experience working on ESA projects • Developed a corporate culture on multi disciplinary subjects
Gamma Medica	• Technology insight, products and performance • Technology awareness, limitations and use
Nammo	• Skills developing, broaden skills with new competence • Exchange of knowledge developing capabilities, production process • Project experience, developing novel technology • Technology insight, products and performance • Composite materials, more knowledge
Spillover **Case company**	
Norspace	• Improved product performance, higher product quality • Higher reliability, increased industrial credibility • Organization, structure, changed routines • Knowledge reuse in development and products
Eidel	• Reuse of knowledge, technology and products saving costs • Increased reliability in commercial products, from reuse
KDA	• Technology reuse on commercial products • Individual competence increase, stronger core capability • Level of awareness, quality increase in commercial products • Product reliability improved
Gamma Medica	• No spillover
Nammo	• Reuse of knowledge, technology and products saving costs • Knowledge diffusion leading to new products

Table 1 Overview of all case companies benefits from ESA contracts

Finally, in chapter seven, the empirical findings are stated, in the form of recommendations and remarks, and a conclusion is drawn on the potential use of the research.

7 Conclusion

This thesis has investigated what economic benefits Norwegian companies have realized from participating in the European Space Agency programs. A goal the European Space Agency and the Norwegian Space Center have stated is that national funding shall generate economic benefits.

Through participating in ESA programs Norway is interested in achieving external synergies or spillovers to other sectors, with the aims that technology transfer and capability development will lead to industrial growth and benefits for other companies and industries. Participating in ESA programs means that Norwegian companies are rewarded with ESA contracts. These contracts involve financial funding, collaboration through a user-producer relationship, and the exchange of knowledge among the involved actors in terms of technology transfer.

The economic benefits gained through ESA contracts has been studied by applying qualitative methods in the form of interviews with the top management of the space division in five companies. These five companies have each been awarded one or more ESA contracts and the benefits they have derived from these contracts has been analyzed with the application of a theoretical framework containing three mechanisms from the innovation literature. Presented by Rosenberg`s theories of technology transfer, Teece, Pisano and Shuen`s theories of capability development, and Henderson & Cockburn`s theories of spillover.

From the outset of the theoretical framework, it might be natural to assume that the ESA contracts lead to technology transfer in form of competence and capabilities to participating Norwegian space companies. Companies that develop and utilize existing capabilities benefit from the transferred of competence through learning by doing.

According to the applied theories, the thesis expected to uncover benefits from technology transfer resulting in spillover. The firm's capability development leads to internal development and spillover, by reusing technology, and externally spillover, through the diffusion of knowledge. Companies awarded ESA contracts gain experience from learning by doing, which should increase the core competence. It was predicted that capability development would, to a large degree, result in new capabilities, which should lead to internal spillover, and ideally external synergies.

7.1 Technology Transfer

Technology transfer is the transfer of technologies, methods, knowledge, or facilities developed for one purpose, for reuse on new or different projects.

According to the respondents, ESA contracts have transferred important funding for four of five companies, while three of five stated that being awarded the contracts also assisted with the establishment of networks beneficial for collaboration. All companies stated that general knowledge was gained in the form of work methods, standardizations, and several types of reviews to ensure the technology and product function met strict requirements. Also, access to a scarce resource, testing equipment for space applications, was emphasized by KDA. Technology transfer provided flight heritage, at least for three of the respondents.

The transfer of ESA`s methodology, in the form of systematic structure and processes used by the companies during the execution, and more importantly after the ESA contract is fulfilled, indicate that good collaboration also means a successful user-producer relationship. It is clear that the companies that manage to adapt strict requirements such as documentation, quality control, and the use of ESA methods, are more satisfied with the collaboration. Firms that are too small, lack competence, or do not want to fulfill the strict requirements of document handling or detailed technical documentation, also miss out on the transfer of technology that is possible from ESA.

The companies benefit from ESA contracts through the implementation of standardized requirements for tests and verifications. Additionally, the companies can realize cost savings and increased reliability and quality for their commercial products, which is paid for by the ESA funding through the awarded contract. ESA`s demands and requirement for quality, testing and validity, are evidence of technology transfer to the participating firms.

7.2 Capability Development

Capability development represents the knowledge gained through learning from projects in the past and is accomplished through learning by doing.

According to the case company EIDEL, the firm gained a better reputation by conducting space projects, giving the company a capability development of confidence and credibility in the market. Learning by doing provides experience according to NORSPACE, while four of the five companies also emphasize technological insight and expertise.
Some firms have evolved the organizational structure and corporate culture; others have acquired new skills in process management, gained knowledge on materials, and increased product awareness and insight.

By developing technology and products, the companies have learned by doing. The reuse of these developed technology and products have led to cost savings from economies of scale for all five companies. For four out of five firms, this reuse has continued for many years. The technology and products are incrementally improved and adapted to changing requirements and customer's demand; therefore, the capability development from this reuse is continuous.

ESA contracts have provided stability in the form of stabile income and market supply, providing necessary income to develop and maintain necessary core capabilities. This is confirmed by considering the evolution of some of the companies, and it emphasizes the importance of stability to the firm`s core capability and core business from technologies or products.

The adaption of ESA methods and the use of the established infrastructure have increased experience and lead to capability development, Norspace, Eidel and KDA, mention that the companies have benefited from flight heritage. Their experience provides evidence of first mover advantages, those companies with flight heritage can more readily gain access to the scarce resources of ESA testing facilities.

However, being a first mover company does not ensure these advantages will be realized because managing capabilities is challenging and establishing a good management is not easy. Four of the five companies have gained first mover advantages, but only three companies have been able to utilize being a first move. Norspace, KDA and Nammo earned positive profits and a dominating position in the market today.

7.3 Spill Over

Spillover is the application of knowledge, such as competence and capability in the form of technology, product, or method, gained from working on a project in one core area to another unrelated area.

Spillover has improved technology and products performance and reliability. In addition, the five firms benefit by reusing knowledge, technology and products for commercialization. According to the respondent`s statements, the reuse of technology and products is the most important benefit gained. Internal spillover has improved technology and product performance and reliability.

In addition, the firms benefit with economies of scale and scope, where scale means reduced administrative costs and manufacturing cost per unit by reusing knowledge, technology and products for commercialization. The companies studied acquired benefits in the form of spillover related to work methods and development of new capabilities that have applications in other non space related areas.

7.4 Potential Use of the Research, Findings and Recommendations

The investigation confirmed findings of the expected benefits by applying the theoretical framework; however, other more important benefits have occurred for these companies. The findings however, are limited by the interview method and the information provided by the case companies.

From the analysis, benefits from ESA contracts differ from expected findings in area, like economy of scale and scope, and important internal spillover in the form of reuse of technology, methods and products. All companies have realized some benefit from ESA contracts, and three of these benefits stand out. Stabile markets generate stable income over a larger period of time. ESA contracts increase the core competence and capability development of the business. The reuse of technology, equipment, structure and methodology reduces risk, and together with economies of scale and scope, save costs, thereby increasing income. ESA contracts contributed to the growth of the case companies, which is confirmed by internal spillover; however, few examples of external spillovers were found.

It is important to note that the firm`s existing capabilities were a determining factor for the utilization of the economic benefits of participating in the European Space Agency programs.

The ESA system is bureaucratic and according to most respondents rigid and very formal, making ESA a demanding and challenging cooperation partner. The firms unable to fulfill all demands miss the opportunity to establish a user producer relationship, build the structures required by ESA, and adapt to the ESA system. Evidence of this can be seen in their struggle to be awarded an ESA contract or their low interest in ESA.

Four of the firms have gained valuable financial economic benefits after the completion of ESA contracts. Only larger companies like Norspace, KDA and Nammo have realized benefits from implementing the ESA systematic methods. It is important to note that these companies have not simply replicated these methods and since these firms have developed structures around the methods, they also developed their non-technical capabilities.

The ESA-system operates on geographical return. ESA invests an amount equivalent to each member state's contribution to the program, in industrial contracts for space programs within that country. According to the Norwegian space center, Norwegian companies receive substantial economic benefits from ESA contracts, for every Norwegian krone the Norwegian industry received from contracts with ESA and NSC, they created additional revenue (spinoff benefit) of 4.7 kroner in 2009 (Amundsen & Eriksen, 2010).

The aim of the participation was to generate industrial growth in the form of spinoffs or spillovers. The thesis empirical findings confirmed companies benefit from Norway's participation; however, this is mainly achieved with economies of scale, rather than external synergies like spin offs or spillover, which is supported by the limited findings.

To accomplish more external spinoffs and spillover the government has to consider altering the means of how the system works today. External synergies to other industrial sectors are limited in the findings, indicating different public incentive is required to accomplish this goal. Also, more effort must be put forth by the companies.

In addition, there is a conflict of interests between the public and the firms. Companies receive public funding and the public wants something in return for their investments. Most companies are not interested in diffusion of their developments and the government`s goal to achieve external spillovers is challenged. This could be emphasized as a potential problem of lock in or path dependency.

Strong incentives to encourage using the existing user producer relationship can help the realization of the firm's own projects. There is some proof that this is a successful investment, because at least one company (Norspace) has gained advantage from proactive use of the user-producer relationship. The firm is less concerned about the diffusion of their technology because they still have first mover advantages in their niche market. One method is to utilize the company`s own capabilities and potential to stimulate more internal spillover. This can lead to applications in a wider range of technology, which can be distant from the firm's core business (Nammo and the gas bottle). According to Mowery and Rosenberg, it is difficult to establish the content of the "learning process that might spillover to civilian production "(Mowery and Rosenberg, 1989, 140). As such, the developments in other industries are not a threat to the core companies, which can easily lead to diffusion of the development and thereby generate external spillover.

I hope this thesis contributes to a better understanding of the broader picture for the public. For the government it is important to legitimize why Norway`s fund space activities. The government could use the empirical findings and the results from the analysis as assistance for general decision making concerning Norway's space activities and for altering, how the system functions today. This will hopefully maximize the benefits, to stimulate spillover and acquire a higher rate of return.

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8.1 Appendix 1: List of respondents from the formal interviews

Company	Position	Name	Date of interview
Norspace AS	Director Business Development	Øyvind Anderssen	(4.Juni 2010)
Eidel AS	Managing Director Project manager Telemetry/Space	Tore Havstein Jan Erik Nordal	(8.Juni 2010)
Kongsberg Defence & Aerospace AS	Vice president, Space Missile Systems	Ole Fiskum	(9.Juni 2010)
Gama Medica, Inc.	General manager	Gunnar Mæhlum	(15.Juni 2010)
Nammo Raufoss AS	Program director	Turi Røyne Valle	(8.September 2010)

Table 2 List of respondents from the formal interviews

8.2 Appendix 2: Interview guide

- ESST and my background
- What I want to know

  Information and understanding of what the companies have gain out of the ESA contract, what they have learned and possibly used in other activities.
- Can I record the interview?
- What happens today and afterwards
  - Time, transcription, opportunity for comment and approval, anonymity, more contact if necessary through, e-mail telephone

✓ Questions

Interview

Warm up

- Name
- Position in the firm today and in the past
- Responsibilities and duties
- Educational background
- How many years have you worked in the firm and at your present position
- Interests in Space

Interview Space projects

Aim to find what economical benefits come from space activity and the system.

1. What products do you produce in your department?
   a. Hvilke produkter produserer dere i din avdeling?
2. How many Space project has the firm been involved?

    a. Hvor mange rom prosjekter har firmaet vært involvert i?

3. Briefly describe the (one) space project process from start to end.
    a. Beskriv kort rom prosjektprosess fra start til slutt.

Actors

4. What actors were involved in the project?
    a. Hvilke aktører var involvert i prosjektet?
5. How often does the firm/department engage in collaboration with external partners?
    a. Hvor ofte deltar bedriften/avdelingen i samarbeid med eksterne partnere?
6. Did you have any contact with them prior to the particular project?
    a. Hadde du noen kontakt med dem før dette prosjekt?
7. Which are the most important institutions (public or private) for your company and do you cooperate with any of these?
    a. Hvilke er de viktigste institusjoner (offentlige eller private) for din bedrift og samarbeider dere med noen av disse?
8. Which part initiated the collaboration, and what were the stated motives behind contact?
    a. Hvem tok initiativet til samarbeidet, og hva var motivene bak kontakt?
9. What role does the public sector usually play in the firm's innovation activities?
    a. Hvilken rolle spiller det offentlige i firmaets innovasjons aktiviteter?
10. Does your firm have ESA-contracts and national Funding?
    a. Har dere ESA kontrakt og følgemidler?
11. Who made the decision (firm, public) about participating?
    a. Hvem bestemte at dere skulle delta (firmaet, offentlige)?
12. How was the space project, financed?
    a. Hvordan var rom prosjektet, finansiert?

13. What was your role within this project?
    a. Hva var din rolle i dette prosjektet?
14. What experience has the firm with ESA collaboration and why is your firm participating?
    a. Hvilken erfaring har foretaket med ESA samarbeidet, og hvorfor deltar din bedrift?
15. Is it a long-term strategy for competiveness? (Or onetime project)
    a. Er det en langsiktig strategi for konkurranseevne?
16. Has the ESA- contract made it necessary to attract new employees (knowledge) or develop the firm, if so what?
    a. Har ESA kontrakten gjort det nødvendig å tiltrekke seg nye medarbeidere (kunnskap) eller tilpasse bedriften, hvis så hva?
17. What are the main factors for the firm, for being attractive and qualify for ESA contracts?
    a. Hva er de viktigste faktorene for bedriten, for å være attraktive og kvalifisere seg for ESA kontrakter?
18. What are the costs and benefits from ESA contract when you think of the outcome?
    a. Hva er kostnadene og fordelene fra ESA kontrakt når du tenker på utfallet?
19. What advantages of participating in ESA contracts are there for the firm?
    a. Hvilke fordeler er det for bedriften av å delta i ESA kontrakter? (levering til andre land utenfor ESA)
20. What strengths and weakness for participating, have you experienced?

Core

21. What is the business definition of where you compete?
    a. Hva er bedriftens definisjon av hvor de konkurrerer?

22. What is your core business and source of potential competitive advantage?
    a. Hva er kjernevirksomheten og kilden til mulige konkurransefortrinn?

Capabilities – Competence – Core Knowledge

23. What is the educational level in this department, and in the firm?
    a. Hva er den utdannings nivået i avdelingen, og i firmaet?
24. In what way does the firm keep up to date with the technological frontier and what is the main source of knowledge (technological) and where does the firm gain new one?
    a. På hvilken måte holder firmaet seg oppdatert med den teknologiske utviklingen og hva er den viktigste kilden til kunnskap (teknologiske), og hvordan tilegner bedriften seg ny kunnskap?
25. What type of competence has the public (NSC/ESA) contributed with in this collaboration?
    a. Hva slags kompetanse har det offentlige (NSC / ESA) bidratt med i dette samarbeidet?
26. What competence or capability was involved from the department/ firm?
    a. Hvilke kompetanse eller evne var involvert fra avdelingen / bedriften?
27. What competence or capability did the firm gain?
    a. Hvilke kompetanse eller kapasitet tilegnet bedriften seg (gevinst)?
28. Can you estimate the importance of ESA contract (project), and how the firm's knowledge (competence and capability), through ESA collaboration is enhanced?
    a. Kan du anslå betydningen av ESA kontrakt (prosjektet), og hvordan firmaets kunnskap (kompetanse og kapasitet), gjennom ESA samarbeidet er forbedret?
29. In what way, does it affect other projects or department?
    a. På hvilken måte, påvirker dettet andre prosjekter eller avdeling?
30. What is the core competence of the firm and this department?

   a. Hva er kjernen kompetanse for firmaet og denne avdelingen?

31. What has to be in place in the firm for technology (knowledge) transfer to be effective?
    a. Hva må være på plass i firmaet for teknologien (kunnskap) overføring å være effektivt?
32. What consequents has the project had for the firm's core competence and other process or products?
    a. Hvilken konsekvens har prosjektet hatt for firmaets kjernekompetanse og andre prosesser eller produkter?

Innovation

33. How often does the company release new products or improvement?
    a. Hvor ofte lanserer selskapet nye produkter eller forbedring?
34. How due space project differ from other projects (products)?
    a. Hvordan skiller rom prosjektet seg fra andre prosjekter (produkter)?
35. What kind of knowledge (technology) does one need to innovate and what are the main factors for the firm to be innovative, does it differ compared to space projects?
    a. Hva slags kunnskap (teknologi) trenger man for å være innovativ og hva er de viktigste faktorene for bedriften å være nyskapende, skiller den seg i forhold til rom prosjekter?
36. What, if any, situations have leaded the space project to be successful?
    a. Hva, om noen, situasjoner har gjort rom prosjektet suksess?
37. Has the firm learnt something from this specific project and if so what was learnt?

    E.g. increased: technological knowledge, new working process, methods, project management, etc?

    a. Har selskapet lært noe av dette spesifikke prosjektet og i tilfelle hva var lært?

For eksempel. økt: teknologisk kunnskap, nye arbeidsprosessen, metoder, prosjektledelse, etc.?

38. What do you consider to have gained over time in this project?
    a. Hva mener du har fått over tid i dette prosjektet?
39. What factors must be present in the firm to stimulate spill over's?
    a. Hvilke faktorer må være til stede i bedriften for å stimulere spillover's?
40. Through the work on this project, has the firm changed process and or products?
    a. Gjennom arbeidet med dette prosjektet, har firmaet endret prosessen og eller produkter?
41. Has there been generated something's from the space project and used in other non-space projects?
    a. Har det blitt generert noe fra rom prosjektet og som brukes i andre ikke rom prosjekter?

Ending

- ✓ Tanks for participating
- ✓ Can I contact them again by telephone, e- mail for comment and approval?
- ✓ Anonymity?
- ✓ Questions