The power of patents

Measuring the socio-economic impact of patents developed at the University of Twente

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Preface

This research is done as a graduation project for the master's program Business Administration, track Financial Management, at the University of Twente in Enschede. The research is commissioned by Octrooicentrum NL, an organization which is located in Rijswijk. The subject of this graduation project widened my view on Business Administration. It gave me the possibility to combine my knowledge on Financial Management with different fields of Business Administration.

I would like to convey my thanks especially to dr. A.H. van Reekum for his guidance, patience, understanding and contribution that he made during my graduation period. His objective view kept me alert and stimulated perfection toward the research. I want to pay tribute to them and all colleagues for creating a nice atmosphere at University of Twente.

I would also like to add my thanks to some professionals: Dr. Ir. R. Kolkman, Ir. H. Kroon, Drs. P. van Dongen and Mr. P. Bijleveld for the support, help and sharing of knowledge with me over the graduation period.

Abstract

This study measures the socio-economic impact of patents which are developed at the University of Twente. The study is part of the RIS project which is organized by NL Octrooicentrum. The measurement on socio-economic impact shows whether patents, which were developed at University of Twente, have a positive influence on employment, involvement on process and new product development, regional prosperity and the chance of getting loans. The data that is used in this study originated from EPO World Wide Statistical Database. Fourteen out of thirty-three questionnaires were returned and analysed. The results show that there is not enough evidence to state that the patents have an influence on employment and the chance of getting loans. The patents of the University of Twente do have a positive impact on the involvement on process and new product development. The patents also have a limited influence on regional prosperity. These findings show that patents created at the University of Twente play a relevant role when considering the socio-economic impact, especially on innovation. Firms using patents developed at the University of Twente are highly involved in process and new product development. This means that the collaboration with universities definitely benefits the stimulation of innovative activities in the in The Netherlands.

Table of contents

Preface 2
Abstract 3
1. Introduction 6
1.1 NL Octrooicentrum; RIS project 6
1.2 University of Twente 7
1.3 Strategy of University of Twente 8
1.4 Problem description 9
1.5 Goal of the research 9
1.6 Research model 9
1.7 Research questions 10
2. Literature review 11
2.1 University-industry collaboration, the process of technology transfer 11
2.1.1 Universities start licensing their inventions 11
2.1.2 Process of technology transfer 12
2.1.3 Technology transfer in a contextual view 12
2.2 Socio-economic impact 13
2.2.1 Definition and conceptualization socio-economic impact 13
2.2.2 Creation of new jobs 15
2.2.3 Level of innovation 16
2.2.4 Regional prosperity 18
2.2.5 Venture capital financing 19
2.3 Patent valuation 19
2.4 Influence of financial crisis on socio-economic impact 22
2.5 Conceptualization 23
2.5.1 Conceptual framework 23
2.5.2 Conceptual model 24
3. Research methodology 25
3.1 Research design 25
3.2 Variables 25
3.2.1 Indicators RIS project 25
3.2.2 Independent and dependent variables 26
3.3 Population 27

3.4 Non-response 28
4. Results 29
4.1 Statistical analysis 29
4.2 Patent valuation at the University of Twente 33
5. Conclusion and discussion 35
Bibliography 39
Appendix 42
Appendix A. Contextual factors 42
Appendix B. Questionnaire 43
Appendix C. Increase in FTE in relation with turnover of the firm 46

1. Introduction

The concept of translating technology arising from studies at universities into entrepreneurial activities for economic prosperity becomes increasingly popular in many countries. Nowadays, companies work under high pressure and are expected to achieve a high performance in a relatively short period. A consequence of this, is that these companies will primarily choose to invest in the technology universities offers rather than investing a large sum of money into basic research and longer-term development with no secure outcome (Shane, 2004; Poltorak & Lerner, 2011). Universities anticipate in this by claiming intellectual property (IP) on the inventions that stem from technology they developed. The intellectual property typically results in a patent which is often enrolled in a spin-off company or an existing company.

In the literature many researchers present ways to raise the effectiveness of technology transfer by using organizational theories and practices, by mapping the process of technology transfer to achieve higher performances and by searching for the best strategies for optimal collaboration between the university and the industry (see, for example, Matkin 1990; Samson and Gurdon 1993; Proctor 1993; Bell 1993). However, only a few researchers try to find the socio-economic impact of university technology transfer on the society in which the university and the industry operate. (See, for example: Mueller, 2006; Siegel et al., 2007).

1.1 NL Octrooicentrum; RIS project

NL Octrooicentrum is part of the Dutch Ministry Economic Affairs and is located in The Hague. They have close collaborations with many (inter)national organizations which are based on Intellectual Property (IP). NL Octrooicentrum provides firms, institutions, governments and inventors uncomplicated patent applications to protect their inventions. Also, they give information about patent systems and guide these organizations how to deal with patents. Next to this, they also perform researches for governments.

Since April 2011, NL Octrooicentrum took the initiative to study the socio-economic impact of patents originating from Dutch universities, and organized the Region Innovation System (RIS) project. The purpose of the project is to prove the importance of technology transfer and commercialization from university to industry by measuring the socio-economic impact of patents originating from universities. This study is performed in collaboration with twelve

Dutch universities. The relations and contributions of these universities towards society is measured by qualitative and quantitative indicators (see Table 1). All participating universities collect their own data but also have the possibility to extend the research, for example, by adding more indicators and additional literature. After gathering all the data the NL Octrooicentrum concludes its research with a final report. The RIS project limits the research by measuring the socio-econonomic impact of the patents that originate from scientific research of universities on entrepreneurship in The Netherlands.

Table 1. *Indicators RIS project (van Dongen, 2012).*

<table>
<tr><th>Qualitative indicators</th><th colspan="2">Quantitative indicators</th></tr>
<tr><td rowspan="3">1. Strategy and mission university</td><td rowspan="12">5. Names of scientific personnel (professors, lecturers, post docs)</td><td>6. Number of graduations</td></tr>
<tr><td>7. Number of doctor degrees</td></tr>
<tr><td>8. Number articles</td></tr>
<tr><td>2. Valorisation policy</td><td>9.Number of patents</td></tr>
<tr><td rowspan="3">3. Mandate and tools technology transfer office (TTO)</td><td>10. Number of patent licenses</td></tr>
<tr><td>11. Number of spin-offs</td></tr>
<tr><td>12. Contribution on innovation</td></tr>
<tr><td rowspan="2">4. Embedding of universities in region/national/international networks</td><td>13. Number of FTE working at spin-off</td></tr>
<tr><td>14. Number of FTE working in firms by patents (no. 9)</td></tr>
</table>

This report focuses on the relations of the University of Twente and their contributions toward the (regional) society. The RIS project is used as a basis of this report, however, each university can determine its own interpretation of socio-economic impact. This means that indicators given by NL Octrooicentrum might be taken into account, but are also completed using different literature.

1.2 University of Twente

The University of Twente was founded in 1961 and formed a collaboration with the Delft University of Technology and the Eindhoven University of Technology. These together are

called the 3TU; the three technological universities of The Netherlands. Until 1973, the University of Twente mainly focused on the development of technological education and courses. Nowadays, different non-technological courses are offered as well (for example; Business Administration, Communication Studies and Educational Science). Since the mid-1980s the University of Twente profiled itself as the 'entrepreneurial' university with the purpose to set up new ventures and create new jobs.

In 2010 the University of Twente brought together the Business Development Team in cooperation with Kennispark. This team exists of three business developers, two lawyers, two Municipal members and one intellectual property expert. Together they protect the inventions and new technologies of the University of Twente by law, in order for them to be exploited commercially. The Business Development Team coordinates the entire process of knowledge translation for the University of Twente: from patent applications for researchers to agreements in licensing. They also monitor performances and maintain collaboration.

1.3 Strategy of University of Twente

Chapter 1.2 gives a short introduction on the history and organization of the University of Twente. However, the vision of the University of Twente towards IP management and socio-economic involvement is not defined.
RoUTe'14+ (2011) is a document developed by the board of the University of Twente. It contains their strategic vision, and a description on how the university wants to achieve its goals.
In this document the important purposes for raising the quality and strengthening the profile of the University of Twente are explained:

- Performing research with a focus on high quality and visibility with optimal use of available equipments and strong interactive relations with the environment.
- Education has to be more efficiently in combination with higher benefits. A broader offer of courses must attract more students: 'the education of the 21th century'.
- Organizing excellent support and a distinctive campus.

The vision of the university is summarized in the following slogan: '*High Tech, Human Touch*'. It is a modern research university with a focus on entrepreneurship. It is important for

the university to become more well-known in society. This is not only important because of their expected contribution on society, it is also necessary. The University of Twente has to strengthen its position towards competitors. Document RoUTe'14+ (2011) states that innovations play an important role in achieving this goal. Socio-economic development plays an important role because the content of courses and technologies are closely related to changes in society. However, goals on intellectual property, patents or technology transfers are not mentioned in this document. Innovations do play a prominent role, but it is not exactly elaborated in what way and how these innovations should be used.

1.4 Problem description

Technology transfer is a concept that is becoming increasingly popular in many countries. Universities, the industry and the government expect a positive impact on economic growth as a result of the university-industry collaboration. Many studies on technology transfer also assume there is a positive impact, but only few have actually analysed this impact (see, for example, Baron, 1993; Parker and Zilberman, 1993; Shane, 2004). In this study the impact of transferred patents created at the University of Twente is studied. Between the years 2000 and 2010 seventy-six patents have been transferred from university to industry and their socio-economic impact is still unknown.

1.5 Goal of the research

The goal of the research is in line with the problem description and focuses on determining the socio-economic impact of patents originating from the University of Twente concerning employment, innovation, regional prosperity and capital financing.

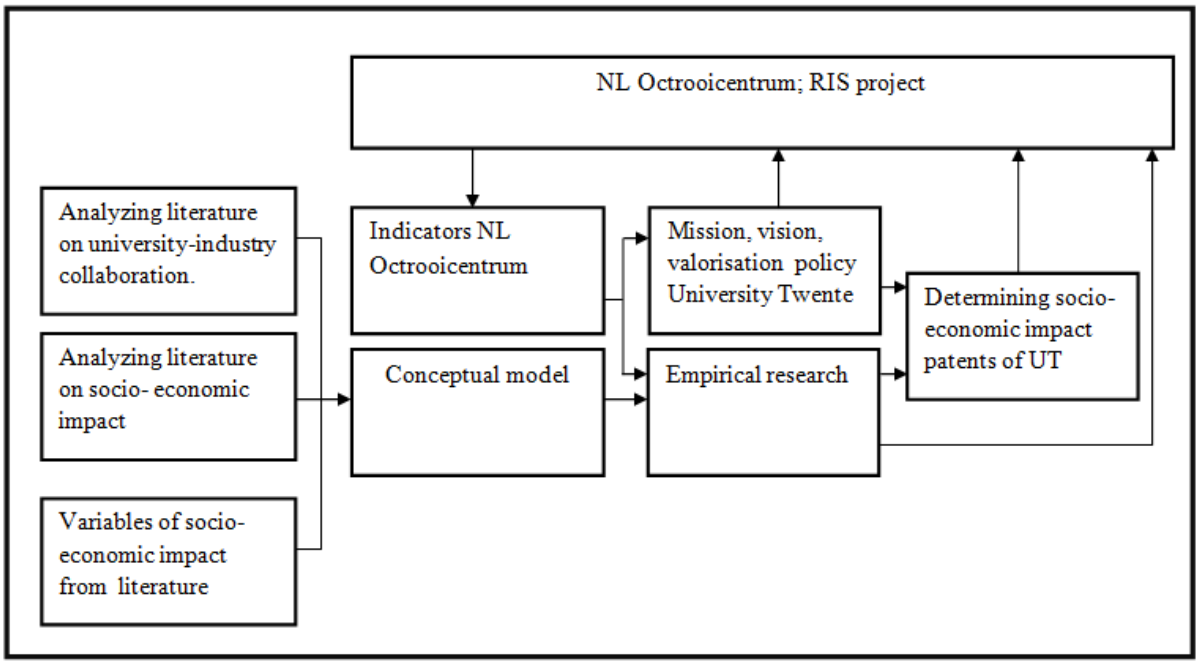
1.6 Research model

To achieve the goal of the research, a research model is developed (see figure 1). The model gives an overview of how the research is conducted.

The model also shows the connection between the RIS project of NL Octrooicentrum and this project. As shown in figure 1, the research is performed in four different stages. First, the theories on the subjects as given in the problem description and the goal of the research are investigated. The literature on university and industry collaboration is then clarified. The incentives of the parties are described as well as the process of technology transfer, and what contextual factors actually influence the collaboration. Subsequently, the concept socio-

economic impact is defined, composed and explained. This stage concludes with variables measuring the socio-economic impact. These variables are based on literature as well.
In the second stage a model is developed which explains how patents influence the independent variables which represent the social economic impact. NL Octrooicentrum has developed a set of indicators, and together with the set of variables found in the literature a questionnaire is developed. In stage three relevant data are collected. After collecting and processing this data, the socio-economic impact of patents of the University of Twente are then determined.

Figure 1. *Research model.*



1.7 Research questions

The central research question is as follows:

What is the socio-economic impact of patents created by the University of Twente in the Netherlands in the period of 2000 till 2010?

1. *How is the university-industry relationship organized?*
2. *How can the concept socio-economic impact be defined?*
3. *What variables are used to measure the socio-economic impact?*

2. Literature review

In this chapter, first, the collaboration between university and industry is explained. Then the term socio-economic impact is clarified as well as the different variables that belong to this term. After this, different methods on patent valuation are explained. The role of the financial crisis on socio-economic impact is also discussed. The chapter ends with a conceptual model on how patents created at the University of Twente are related to socio-economic impact and what role the financial crisis has on socio-economic impact.

2.1 University-industry collaboration, the process of technology transfer

For studying the socio-economic impact of patents that originate from universities, the process of how patents are being transferred from university to industry is explained. This process is known as technology transfer. Technology transfer is one of the various types of university-industry collaboration. In this section, an overview is given of how the development of technology started. The process of technology transfer is explained and the incentives of the parties to work together are studied. Then the process of the term technology transfer is further clarified providing an overview of what contextual factors actually influence technology transfer of the industry and the university.

2.1.1 Universities start licensing their inventions

In the last few decades, the role of universities towards society and towards the purpose of scientific research has known several changes. Especially today's research universities do no longer stay in traditional roles of teaching and conducting primary research, but start to bring theory in practice. Especially research universities start collaborating with the industry with the primary objective to stimulate entrepreneurial activity and economic growth.

The concept arose in the U.S., where in the late 1970s universities began to patent and license their inventions and started to implement the results of academic research in the field. The implementation had success and was a beginning of a new phenomenon: the transfer of technology from universities to the industry. Since the adoption of the worldwide known Bayh dole act[1] in 1980, the patent and license requests doubled. The success of this concept extended to Europe (Tihanyi & Roath, 2002; Van Looy et al., 2006).

[1] Legislation which deals with intellectual property that originate from federal goverment-funded research. http://www.autm.net/Bayh_Dole_Act1.htm, 18-09-2012

Universities also experience pressure of the government. Structural government funds which were used to accomplish scientific research have declined and are often replaced by competitive funds in order to generate an additional source of income, and in many cases to compensate for the decrease in government funding.
This development was another incentive for universities to collaborate with the industry and thus, to patent and license their inventions. (Geuna & Nesta, 2006).

2.1.2 Process of technology transfer

Technology transfer of universities is a process that can be explained in sequential steps (Harmon et al., 1997). It starts with the support of the government for basic research in universities. This is continued with determining the inventions that arise from research in order to protect them with intellectual property. The second step for the university in this process is to make a selection of entrepreneurs who have sufficient qualifications to operate with the invention. This belongs to the process of 'technology licensing', where inventions get licenses for companies to develop it. Coming to an agreement between both parties is tough; on one hand the agreement must give the new firm enough fundamentals to operate, and to give confidence to investors, and on the other hand it must provide the university with the assurance that the technology will be developed securely. (Shane, 2004).

Next, the new venture has licensed the invention and will accomplish it in practice. The final step of the process concerns marketing. The marketing of the product can be done only by the venture, or in collaboration with other large companies.

Positive consequences of technology transfer are; a closer university-industry partnership, an increase in understanding each other and education in entrepreneurship for students and faculty. There are negative consequences for the university as well, these include distortion of the direction of research, conflicts of commitment by faculty and the actuality of conflicts of interest. (Harmon et al.,1997; Shane, 2004)

2.1.3 Technology transfer in a contextual view

Although the general process is the same for all transfers, there are different types of transactions between universities, start-ups and bigger, established firms. The goals of the universities might differ as well in comparison to the goal of the firms. Universities are bureaucracies with their own rules, interests and incentive systems, and have to take into

account a variety of objectives, in contrast to commercial firms whose basic aim is to make profit.

Bercovitz and Feldmann (2006) developed a conceptual model which gives an overview of the relation of university and industry (see appendix A). University and industry relations are based on a series of sequential transactions from university environment to transactions ending in firm characteristics. Many studies are focused on these transactions in order to make them more effective and efficient. Their model shows that the university and industry collaboration does not simply exist of the sequential process. Contextual factors as parameters set by government, industry characteristics and behavioural attributes of both parties highly influence the collaboration. To achieve a successful collaboration between university and industry, it is not only the transaction that counts. Contextual factors have to be taken into account to come to the best results.

2.2 Socio-economic impact

Socio-economic impact is a complex concept in terms of defining and measuring the term. In literature, the term is used in several occasions, but the exact definition of the term is poorly explained (Martin, 1997; Berman, 1989). In this chapter, the definition of socio-economic impact is given and is conceptualised. Subsequently, different variables are determined to measure the socio-economic impact in this study.

2.2.1 Definition and conceptualization socio-economic impact

In order to study the socio-economic impact of patents of the university-industry collaboration, it is relevant to define what 'socio-economic impact' means. The Dutch dictionary Dikke van Dale defines socio-economic as: 'something that has to do with social as well as economic'. Obviously, this definition is too vague to be useful for this project. Many scientific researchers have their own perspective on socio-economic impact. Often it is considered as '*The use of economic variables in a study of society'*. Remarkable is that many studies use the word socio-economic impact but do not define or conceptualize this concept. The studies also use different variables for measuring the impact. (Berman, 1990; Martin, 1998; Shane, 2004).

Valorisation is a concept that drew much attention the last few years. This term is not used often in international literature, however, in The Netherlands and Belgium it is a common term. Valorisation can be defined as:

…an interactive process that converts scientific knowledge to be used in practice for the improvement and inventions of competing products, services, processes or new ventures. The purpose of valorisation is value contribution of scientific research in practice. (AWT, 2007; STW 2011).

This term might be more interesting to help define socio-economic impact rather than technology transfer. Whereas technology transfer focuses only on the process of bringing the technology into practice, valorisation goes in depth, and focuses on the value contribution of scientific research. This value contribution (read: impact) is exactly what we want to measure in this study. Valorisation makes scientific results available in order to be used by everyone.

According to AWT (2007), there are two different ways of valorisation, the first is economic valorisation and includes its economic value to society. The other term is known as social valorisation and includes the contribution in social contexts, cultural ways and democracy. In this study the term economic valorisation is defined as follows:

… converts the scientific knowledge into economic value. (AWT, 2007)

The socio-economic impact could also be regarded as the economic value that derives from economic valorisation. With economic value one considers developed products (sometimes) for the purpose of earning money, for the purpose of employment and of innovations. But also the increase of efficiency and effectiveness in ventures or implementing a cost effectiveness analysis are included in the term economic value. Unfortunately, this definition does not take social aspect of value into account, therefore this term is not used.

As mentioned before, socio-economic impact can be compared with the outcome of valorisation. But it remains an abstract definition which is hard to measure. Technology foundation STW published a report in 2011 where indicators for the outcome of valorisation for different situations are pronounced. In their research it is state that it is impossible to measure valorisation just by simple counting's. A combination of qualitative and quantitative

data is needed to determine what impact economic valorisation has on society. Even when combining qualitative and quantitative indicators there are some problems concerning validity and reliability. These issues will be further discussed in chapter 5.

In order to determine the socio-economic impact in a valid way, quantitative as well as qualitative data is used. As shown in table 1, the qualitative variables of the University of Twente are identified. Qualitative variables show the relation between the university and socio-economic impact. It gives insight on whether targets are being achieved, and how this could be improved.

Then data of quantitative variables is collected by means of a survey. Based on following literature different hypothesis is developed.

2.2.2 Creation of new jobs

Universities that invent, develop and design claim intellectual property (IP) on the inventions and technologies they have made. This IP often results in a patent or a license. The collaboration between university and industry encourages the patent or license to be passed on to the industry in a form of (for example) a spin-off company. This is a completely new corporation that is established to introduce the new technology to the market. By setting up a new venture new jobs are definitely created. The second way of dealing with the patent is to sell the patent to a multinational company. In the case of licensing, the patent could be licensed to a multinational. In both cases new jobs are created, even though it may be in an existing company. Another possible advantage of the university- industry collaboration is that unemployment under graduated students (an increasing problem in Twente[2], The Netherlands[3]) may be reduced. For companies the university is a cheaper source of labour (Slaughter et al., 2002). Graduated students have the advantage to have a job after completing their study.

Most of the studies on technology transfer and university-industry collaboration claim that technology transfer leads to job creation (see, for example, Baron, 1993; Parker and Zilberman, 1993; Shane, 2004). Despite the fact that the socio-economic impact has barely been analysed, this impact is often claimed to be already significant (Harmon, et al., 1997).

[2] http://www.regiotwente.nl/algemene-informatie/persberichten/320-werkloosheid-in-twente-stijgt-onder-hoog-opgeleiden
[3] http://www.nrc.nl/carriere/2012/08/30/afgestudeerden-steeds-moeilijker-aan-de-bak/

The amount of studies on technology transfer may be small, there are still some studies done on job creation of spin-offs firms. The University of Linkoping in Sweden created 53 spin-off companies that generated 650 full-time jobs in the region of the university (Blair and Hitchens, 1998). Baycan and Stough (2012) showed in their study that the University of Twente in The Netherlands created 92 companies in the period of 1984 till 1992. These spin-off firms created 445 jobs. Blair and Hitchens (1998) also show in their study that the University of Liège, located in Belgium, created 25 spin-off firms from 1986 to 1994, and these firms created 250 jobs.

However, it has to be taken into account that these researchers did not make distinctions in the different categories of spin-off firms. This means that the spin-off firms in their study include both research-based spin-off firms and patent-based spin-off firms. The different categories are explained in chapter 4.

Assuming that university-industry collaboration leads to new ventures and to new vacancies in the existing industry, the following hypothesis is developed:

> ***H1***. *Patents created at the University of Twente in the period of 2000 till 2010 positively relate to employment in the related ventures of the University of Twente.*

2.2.3 Level of innovation

In her study, Mueller (2005) adresses the university-industry relation and the impact on regional economic growth. Her findings show that regions with a high level of entrepreneurship experience a high level of economic performance. Especially new firm formation in innovative industries play a crucial role in the commercialization of knowledge. Universities are seen as a source of innovation. The more firms there are to gain knowledge generated at universities, the higher the economic performance in these regions (Mueller, 2005).

As mentioned in the previous section, new firms lead to job creation. When an increase of start-up firms is expected due to the university-industry collaboration, it is not surprising that the government supports this collaboration. However, the survival rate of start-up ventures is not that high and as a result of the financial crisis the amount of start-up ventures to go bankrupt has increased (Mann, 2011).

There is a growing consensus among professionals in the area of business failure that financial or sales incentives are not enough to pass the survival stage of the venture (Gartner et al., 1988). Management and technical knowledge/assistence are necessary to increase the survival rate of start-up ventures. Gartner et al. (1989) showed that entrepreneurs who spent more effort on activities such as acquiring technical expertise had a higher surviving rate in relation to entrepreneurs who spent less effort acquiring technical expertise.

Audretsch (1995) shows in his study that, depending on the industry, the level of innovation plays an important role for the survival rate of a new venture. His findings indicate that new ventures entering a high innovative industry have more difficulties during the first years, then new ventures entering a non-innovative industry. For example, new ventures entering a strong innovative mobile industry, with competitors like Samsung and Apple, have low survival rates in comparison to new ventures entering the butter industry.

However, when the new venture survives the first few years in the innovative industry and is able to adapt completely to the innovative environment of the industry, the new venture will experience a higher level of growth and will achieve a higher survival rate in comparison to the new venture in a non-innovative industry. Returning to the example, this means that the new venture, that survived the first few years in the mobile industry, had a difficult time, but was able to adapt to the environment of the industry and therefore now (in post-entrance stage) has a lower chance of going bankrupt. The new venture who entered the butter market, had little start up difficulties the first few years, but experiences now (in post-entrance stage) more difficulties with competitors then the venture in the innovative industry. Their survival rate decreases during this stage.

The university-industry collaboration results in an increase of knowledge in the field of innovation and R&D knowledge in (start-up) ventures. The result is that the socio-economic problem, failure of start-up ventures is attacked, and as a result, the surviving rate of start-up ventures is increased.

Based on this assumption, the following hypothesis is made:

> ***H2.*** *Ventures owning patents created at the University of Twente in the period of 2000 till 2010 that are actively involved in product development based on the patent, are also actively involved in process development.*

2.2.4 Regional prosperity

The previous sections showed that job creation and the increasing knowledge on innovation and R&D contribute to economic growth. Several studies have shown that the growth of spin-off companies is a valid indicator of regional economic prosperity (see, for example, Capello and Camagni, 1998; Keeble, 1997). Clayman and Holbrook (2002) showed in their study, which was performed in Canada, that spin-off companies are a significant determinant of economic growth. However, they also point out that spin-off companies only contribute to economic growth when these firms survive and succeed.

Wallin and Dahlstrand (2006) studied the importance of spin-off firms in Sweden towards industrial growth. They showed that spin-off firms are important for industrial growth. Their results show that these spin-off firms contribute to industrial growth by creating new employment during the investigated period. Besides that, spin-offs have high growth and survival rates due to the high degree of technology transfer in new markets.

Spin-off firms contribute to regional economic growth by creating employment and having high rates of survival and growth. Next to these impacts, spin-off firms have a different strength, and that is the transfer of existing know-how at universities. Knowledge that is created through research at universities is transferred by spin-off firms in processes and products. The transfer of this knowledge influences the regional development positively (Drucker and Goldstein, 2007).

Since the University of Twente has been active with spin-off firms for at least a decade, one could expect an economic growth in the region. Spin-off companies contribute to economic growth by creating employment, having low rates on bankruptcy, having high growth rates and by transferring existing know-how from universities to practice. However, in recent years one just started noting officially how many patent-based spin-off companies have started at the University of Twente. There are no official numbers before the year 2000. Therefore, it is interesting to see whether these spin-offs created employment and whether they are involved in innovation. Based on these assumptions the following hypothesis is created:

> ***H3.*** *Spin-offs owning patents created at the University of Twente in the period of 2000 till 2010 experience a growth in employment and in innovative activities.*

2.2.5 Venture capital financing

An increase in the rate of bankruptcy of start-up ventures was just one example of the consequences of the financial crisis. Because of high uncertainty and risks in the current economy, banks and other investors have become very cautious to invest in and provide loans to young firms. This development discourages entrepreneurship in general, especially for those innovative, technological firms with high start-up expenses.

Haeussler et al. (2009) argue in their paper that patent applications and portfolios play crucial roles when it comes to venture capital financing. Today's investors seek certainty. Relying on the patent portfolio of the venture, the investors have some certainty because they have the possibility to analyse the potentials of the portfolio. The results of this study show that ventures owning patent applications increase the chance of having venture capital financing. Further, they showed that the decision on venture capital financing depends on the quality of patents. Firms owning qualitative patents received venture capital financing faster.

This finding is elaborated by Cao and Hsu (2011). Cao and Hsu stated that the role patents could play a role in the information and announcement process. They point out that start-up ventures that are active in patent activities decrease the information asymmetry that occurs between entrepreneurs and investors effectively. This reduces the uncertainty investors might have towards the start-up venture and increases the likelihood that the venture capitalist invests in the start-up venture.

It is obvious that start-up ventures have problems financing their firm in the beginning stage, and that the global credit crisis has even worsened this issue. If these firms start with patent activities in an early stage they increase the likelihood of being financed by venture capitalists. Based on this, the following hypothesis is derived:

> ***H4.*** *Firms using the patents of University of Twente created in the period of 2000-2010 are positively related to receiving finance from venture capitalists.*

2.3 Patent valuation

Previous chapters show what impact patents could have on the socio-economic environment. However, the topic patent valuation has not been discussed yet. It is obvious that an invention is patented, only when the inventor expects financial return. Once the patent is acquired, the firm has to pay annual fees for maintaining the patent. However, the expected return is not

equal for all patents and many patents do not result in any return at all. In order to reduce costs of patents it is interesting for universities to valuate an invention before deciding to patent it (Mazzoleni & Nelson, 1998). It is even more interesting to test if patent valuation is related to impact. When a patent is valued higher than others, it is likely that a higher impact can be expected. Obviously, applying for patent valuation leads to reduce in costs, and it can be used as a tool in order to raise socio-economic impact.

Literature describes different methods and types of patent valuation, each emphasizing different elements of patents. There are three types of basic valuation methods, namely cost approach, market approach and income approach (Mard, 2001; Pavri, 1999).

Cost approach

The cost approach is based on the economic principle that patent value is based on the amount of expenses needed for the development as achieved for the technology. The cost approach is basically built on two fundamental types of costs, these are the reproduction costs and replacement costs. The reproduction costs valuation model considers expenses in order to reproduce a duplicate of the patent that has been patented. Parameters in this method are historical costs. The replacement costs valuation method differs from previous methods because of the summarized expenses required to produce a patent with the same potential benefits (Pöltner et al., 2011).

Market approach

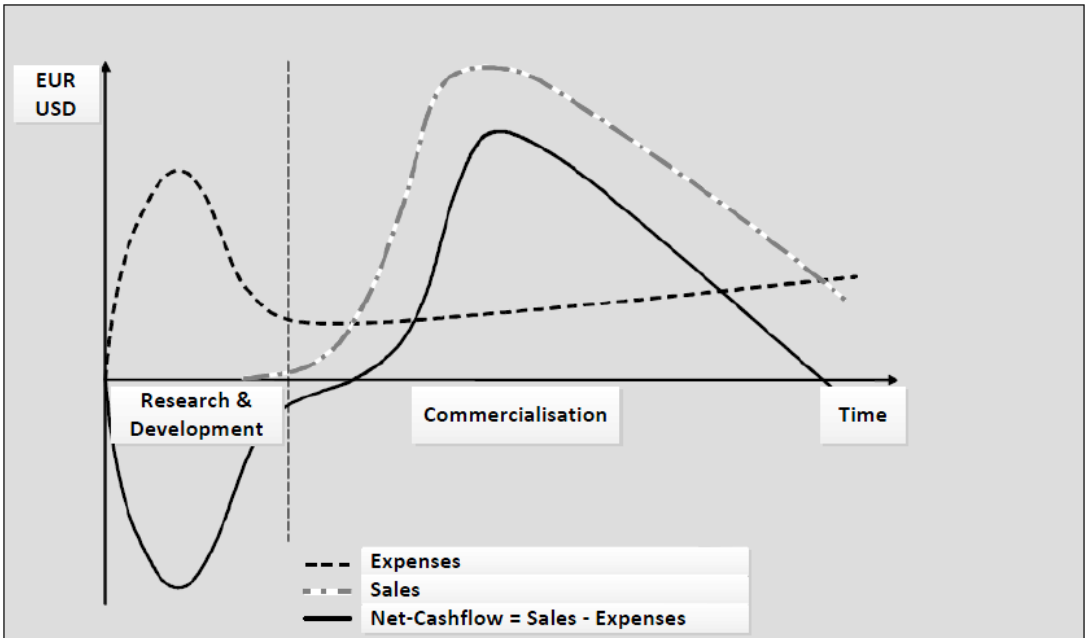
The market approach is based on the price that a potential buyer would pay or has paid for comparable patents. This valuation method has three key market approach methods for estimating the patent's value. These methods are known as; transaction method, royalty method and the residual value method (Smith & Parr, 2000). The market transaction method and royalty rate method show similarities because they examine an existing market which are traded on the market. The market transaction method regards previously similar sold patents, and the royalty rate method takes received royalty rates into account. The residual value method from Parr is based on compact value and is only valid for one product of a firm. This method is calculated by subtracting all fair values of all assets related to the patent from the market value of the company. This approach is especially useful when there is a large amount of information about the valuation of patents in the market. However, each patent is different

which makes it difficult to find similar transactions. Besides that, not all patent valuations are published. Therefore it is not common to use this method for patent valuation. In the future, when patent valuation is applied by firms more often, more information about patent valuation will be published. Therefore, this method might be used more in future, because firms will be more actively involved in patent valuation.

Income approach

The income approach is frequently used and based on the principle that the future cash flow of the company is capitalised with the cost of capital. Figure 2 gives an overview of how cash flows develop in companies over time. As is given in the graph, cash flows are negative in the beginning of the product lifecycle. Because the cash flows are negative in the first place, it is very hard to estimate the possible positive cash flows for patent valuation. Cash flows are not the only parameters in income valuation approach. Together with the discount rate, risks and the patent lifetime one can determine the value of the patent. These general assumptions have led to different valuation methods (Pöltner et al., 2011).

Figure 2: *Cash flow development over product lifetime*.



1. Net present value

The net present value calculates the value of the patent by taking the free cash flow of the final patent into account. This method has a low risk of misinterpretation and can be used in

cases where the cash flow can be linked to a specific patent. The calculation of NPV is given in the formula below.

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0$$

2. Residual value method

This method is used when the cash flow cannot directly be linked to the product utilising the patent. Here, the general value of the product is calculated first, then, the value of other assets (fixed assets, trademarks etc.) is subtracted. The remaining value equals the value of the patent.

3. Relieve-from-royalty method

The last method is calculated in three steps. First, the royalty rate has to be found, second, the saved expenses have to be estimated by estimating the possible 'one-time fee' for the royalty rate. And finally, the capitalisation rate has to be used for discounting potential future savings.

2.4 Influence of financial crisis on socio-economic impact

The global financial crisis of 2008 had a major impact on the financial sector and made financial decisions more difficult for banks, the government and for companies. Nowadays, many companies still experience the consequences of the crisis, especially the medium-sized and small companies. As mentioned in chapter 3.5, the rate of bankruptcy of start-up ventures increased, and investors have become cautious in financing young firms. This is confirmed by the study of de Swaan et al. (2011). They show the relation between the financial crisis and socio-economic impact. Larger companies do not have problems receiving finance from banks and their need for external finance is quite low. Medium-sized and small companies have difficulties in receiving finance, which has consequences for the recovery of their losses in the period of 2007-2010. Banks regard medium-sized and small companies as high risk companies. Therefore these companies have a lower possibility of getting financed and have to deal with strict conditions. It might be interesting for these medium-sized and small companies to raise their equity by sharing stocks with shareholders. However, research from EIM (2011) shows that companies are not willing to raise their equity this way because they do not expect to attract shareholders, because they think it is expensive or because they do not

want to share supervision. The financial crisis obviously had and still has a direct impact on medium-sized and small companies. Because it is harder for these companies to receive any external finance they are limited in their growth, which indirectly affects the socio-economic impact in a negative way. (Fraser, 2012)

2.5 Conceptualization

Socio-economic impact and other terms are be conceptualized in 2.5.1. The conceptual model is explained in 2.5.2.

2.5.1 Conceptual framework

The terms technology transfer, spin-off firms and socio economic impact have already been discussed, however, in order to avoid confusion, an overview of the definitions of these terms are given here.

1) Region: *In this study the surrounding area of Enschede, Overijssel and Gelderland, is meant with the term: region*.

2) Socio economic impact of patents: See the definition of valorisation.

3) Spin-off firm: *Kennispark Twente points out four different kinds of spin-off firms. An explanation of each of the four spin-off firms is given below. When the term spin-off firm is used in this report, the patent-based spin-off firm is referred to*.

   a. Patent-based spin-off firm: *"A new company founded to exploit a piece of intellectual property created in an academic institution."* (Shane, 2004)

   b. Research-based spin-off firm: Some researchers use the definition patent-based spin-off firm to describe research-based firms as well. However, Kennispark distinguishes these definitions in order to avoid confusion. *"A firm that is established based on academic technological research developed knowledge and/or prototypes, which are not protected by patents."* (Kennispark, 2012)

   c. Ecosystem based spin-off firms: "*Established firms with support from valorisation strategy of universities developed start-up facilities. For example: loans, venture capital, coach training or incubators*." (Kennispark, 2012)

d. Alumni-based spin-off firms: "*Companies founded by anyone who has studied or worked at a university."* (Roberts, 1991)

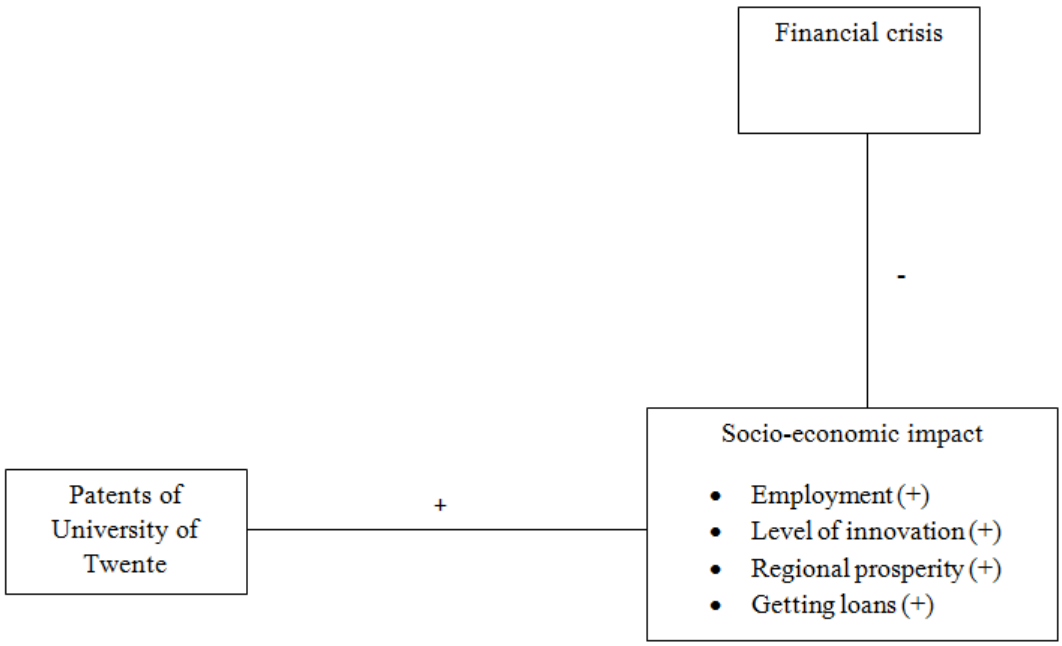
4) Technology transfer: *Refers to the process where technology or invention from a scientific research is patented or licensed to provide rights to a company. This invention could eventually be commercialized.*

5) Valorisation: *Valorisation is an interactive process that converts scientific knowledge to be used in practice for the improvement and inventions of competing products, services, processes or new ventures. The purpose of valorisation is value contribution of scientific research in practice.* (AWT, 2007; STW 2011).

2.5.2 Conceptual model

The conceptual model, shown in Figure 2, gives an overview of how the variables are expected to be related. As mentioned in the literature review (Chapter 4) patents are expected to be positively related to socio-economic impact (Baron, 1993; Mueller, 2005; Capello and Campagni, 1998; Haessler et al. 2009). The variables that belong to socio-economic impact are employment, level of innovation, regional prosperity and getting loans. The financial crisis is negatively related to socio-economic impact (Knowles, et al. 1999; McKenzie, 2004).

Figure 3. *Conceptual model.*



3. Research methodology

This chapter focuses on the methodology of this study, including the research design, and the operationalization of variables followed by the data collection method.

3.1 Research design

This study is performed analysing the timeframe of the year 2000 till 2010. The period exceeds one year and is therefore a longitudinal study. Besides that, the study uses a deductive approach. As discussed in Chapter 2, first, several theories are collected, and based on these theories hypothesis are derived, which are then tested.

The RIS project prescribed different indicators for measuring the socio-economic impact. To provide a valid overview on socio-economic impact, these include qualitative indicators as well as quantitative indicators (STW, 2007). The data of qualitative indicators is obtained by desk research and interviews. The data of quantitative indicators is obtained by means of desk research and surveys.

As mentioned in paragraph 1.1, universities have the possibility to extent the research with additional literature and indicators. In this study four different variables are added to the study based on previous literature (see Chapter 2). All the hypothesis are tested in a quantitative way by means of a survey (see Appendix 2). This method is chosen because the size of the sample (N=33) and standardized answers are required for testing hypotheses and analyzing data.

The survey has been developed by NL Octrooicentrum and is based on their final indicators.

3.2 Variables

In the next part, the operationalization of different variables is given. An overview is given in Figure 2. First, the indicators are clarified, and then, the dependent variable is explained, followed by the explanation of the independent variables.

3.2.1 Indicators RIS project

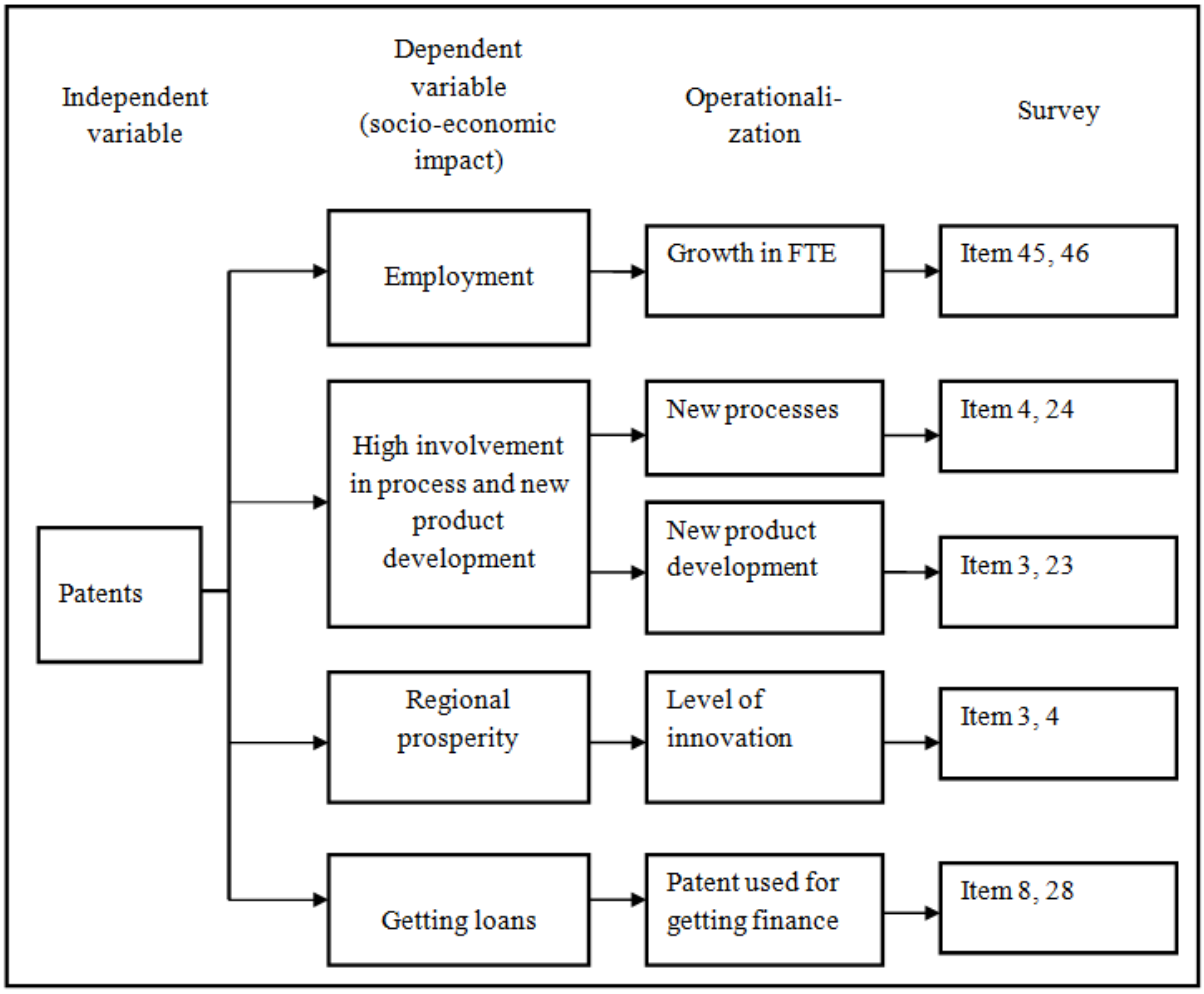
As mentioned in Chapter 1 the RIS project exists of qualitative variables as well as quantitative variables. An overview of these indicators is given in Appendix 2. However,

when using indicators in the research, one has to take into account the validity and reliability of indicators. This is explained in chapter 5, the discussion.

3.2.2 Independent and dependent variables

Since socio-economic impact is expected to be affected by patents of the University of Twente, patents could be called the independent variables and indicators that belong to socio-economic impact could be called the dependent variables. An overview is given in Figure 4. It was argued that patents of universities could affect employment by established spin-offs or existing ventures (Baron, 1993; Parker & Zilbermann, 1993; Shane, 2004). This can be measured by the growth of FTE during the time the patent is bought till now. According to Mueller (2005) patents are a source of innovation knowledge from universities.

Figure 4. *Overview of independent and dependent variables*.



Audretesch (1995) showed that start-up ventures with a high level of innovation knowledge have a lower chance of business failure. This is measured by examining whether the firm has their own R&D activities, whether it started new processes based on the patents and whether the firm has applied incremental innovation based on the patent.

Clayman & Hook (2002) showed that spin-off firms play an important role in regional prosperity. Here, the amount of spin-off firms from 2000 to 2010 is calculated. The authors Haussler (2009) and Cao & Hsu (2011) argue that new ventures owning patents give financial investors more certainty to invest in these firms. The socio-economic impact is that these ventures have fewer difficulties getting loans. In this study, this is measured by examining how important finance is for the ventures, and by examining whether the firm has used patents in order to get financed.

3.3 Population

The population originates from EPO World Wide Statistical Database (PATSTAT). This database includes the data of 295.371 patent applicants since 2000. In this database, at least one of the inventors comes from The Netherlands. First, this list was matched with the list that the University of Twente had handed in. (The list includes all active employees of University of Twente in the period of 2000 till 2010). The first five letters of the surnames of the employees of the University of Twente were then matched with the names on the patent list. This reduced the list to about 10.000 patents which were somehow related to the University of Twente. Secondly, the employees of the university were matched. This time each patent was checked by looking at the name of the inventor, the birth date of the inventor and the working period. The final population exists of 75 patents of 33 different firms (including 3 multinationals). Because the population is this small, no sample is calculated. All 33 firms were approached to fill in the survey. The data is collected by means of these surveys. The total population is 33 firms (N=33). The firms who own the patents are called and the responsible of department IP or patents is asked to fill in the questionnaire. The response rate after the first measurement was 27,3%. The response rate after the second measurement increased to 42,4%. The questionnaires which were filled in after the first measurement as well as after the second measurement are both used for further analysis.

3.4 Non-response

The question that should be taken into consideration is to what extent the results can be generalized for all companies who have used patents of the University of Twente. The final population existed of 33 companies, of which 14 have replied. So, 14 useful questionnaires were returned. 14 of the 33 companies responded (42.4%), which is a lower response percentage than expected. 42,4% is however quite a high number for social research, though, assuming all these companies have a relationship with the university at least a minimum of 60,0% was expected to respond.

It was not always easy to find the responsible person in a company who could tell exactly what happened with the patent. Especially in larger companies (companies not operating in the region), reorganization had happened and did not know what happened with the patent. Even when patents still seemed to be active according to NL Octrooicentrum' register, it was hard to find out what happened to it. Due to a lack of good IP management in these companies, the firms were not aware they were still paying for the patent. It also occurred that persons were not aware that the patent was based on university collaboration.

In other situations the patent was acquired by other companies whose IP management was organized in headquarters abroad. It also occurred that the responsible person for a particular patent had left the organization. It was then hard for the new person to fill in the questionnaire concerning the estimation of the impact of this particular patent, because they had not been involved with the patent at first.

When performing field research, all companies were called and asked who was responsible for IP or patents within the organization. Their personal e-mail addresses were collected and the questionnaire was sent to them. It is not possible that questionnaires were received too late or addressed to the wrong person.

Another reason for the low response could be the limited practicality of the survey. The survey was sent in a word file of three pages which might have given the impression that it was difficult to send it back. This might have been an obstacle for some respondents to fill in the survey.

4. Results

In this chapter the results of the survey are discussed. First, a general overview is given. Then the impact of patents of the University of Twente on labour, level of innovation, regional prosperity and venture capital financing is shown.

4.1 Statistical analysis

In the period of 2000 till 2010 76 patents were applied by researchers of the University of Twente. However, they did not end up in 76 different companies, some were taken over by the same firm. In NL Octrooiregister (all applied patents of The Netherlands are registered in here) one can see the status of the patent. It appeared that more than one third (34.7%) have an expired status. These patents were mostly expired because companies did not pay for the patents anymore. 49 patents were still active and were distributed over 33 different firms. As mentioned in Chapter 3, all 33 firms belonged to the population. 5 companies refused to cooperate filling in the survey from the beginning. These 5 companies did not operate in the region of the University of Twente. Field research had a final response rate of 42.4%.

Table 2 gives an overview of the incentives of companies in patenting. Most of the companies (85,7%) use patents to promote their innovative image towards stakeholders and the market. Patents are also being used to prevent others from entering the (niche) market (42,9%). Less firms work with patents to receive loans from investors (28,6%).

Table 2. *Incentives of companies in patenting.*

Incentive	Variable	n	%
Used patent to receive loans	Yes	4	28,6%
(n=14)	No	10	71,4%
Used patent to promote innovative image	Yes	12	85,7%
(n=14)	No	2	14,3%
Used patent to prevent others entering niche market	Yes	6	42,9%
(n=14)	No	8	57,1%

In order to test the first hypothesis, patents created at the University of Twente in the period of 2000 till 2010 positively relate to employment in the related ventures of the University of Twente, the non-parametric test Mann-Whitney U is used. This test is used to compare the differences between two independent groups when the dependent variable is ordinal or ratio

distributed. The median score of FTE in both years are given in Table 3 (under mean rank). These scores are determined by placing the given numbers of each company in order of rank. After this, the mean rank of each group is calculated.

Table 3. *H1: patents created at the University of Twente in the period of 2000 till 2010 positively relate to employment in the related ventures of the University of Twente*.

Variable*	Year (Mean rank)		P-value**
	January 2011	November 2012	
FTE (n=14)	14,32	14,68	-0,115

*Variables are denoted as median [inter quartile range]. **Group differences were tested with the Mann-Whitney U test.

H1 states that patents that are created by the University of Twente are positively related to employment in the University of Twente related ventures. It seems there is a small increase in mean rank of FTE from January 2011 till December 2012. However, given the p-value of -0.115, and assuming $\alpha = 0.05$, one cannot say that FTE has grown significantly in November 2012 in comparison to January 2011. So even though there is an increase in mean rank, the number in change is too small to state that this growth is significant. H1 is therefore not supported.

Although H1 is not supported, it is interesting to see what kind of firms did experience growth in FTE in times of financial crisis. As can be seen in Table 4 (see Appendix 3) the small firms with low turnovers were not able to increase their FTE compared to big companies (with relatively high turnovers).

H2 states that ventures that own patents created at the University of Twente that are actively involved in new product development are also actively involved in new product development based on the patent. Table 4 gives an overview on the level of involvement in innovation of these ventures. 64,3% of the firms developed a product based on the patent, whereas 50,0% of the firms developed a process based on the patent.

Table 4. *Involvement in innovation.*

Involvement in innovation	Variable	n	%
Development of product based on patent (n=14)	Yes	9	64,3%
	No	5	35,7%
Development of process based on patent (n=14)	Yes	7	50,0%
	No	7	50,0%

In order to test the hypothesis it is interesting to see whether these two indicators are related to each other. These results might give answers about the degree of involvement in innovation. The relationship between the development of a product based on a patent with the development of a process based on a patent is shown in Table 5.

Table 5. *Relationship between product development and process development*.

Cells contain - Row percent - Weighted N		Development of process based on patent		
		Yes	No	ROW Total
Development of product based on patent	Yes	6 66,7%	3 33,3%	9 100,0%
	No	1 20,0%	4 80,0%	5 100,0%
	COL Total	7 50,0%	7 50,0%	

It seems that ventures that create new products based on the patent often are developing a process based on the patent as well. On the other hand, the ventures that did not create a new product as consequence of acquiring the patent, were also not involved in process development based on the patent. It can be said that ventures making use of patents created at the University of Twente are highly involved in innovation, and therefore H2 is supported.

For testing the third hypothesis, cross tables are used. H3 states that companies operating in the region of the University of Twente are positively related to employment and innovative activities. Relying on the data shown in Table 6, only half of the ventures operating in region experienced growth in FTE. Based on this information, one cannot state that all ventures experienced growth in FTE. The difference in numbers is too small. Interesting, however, is to see that ventures that did not operate in the region experienced no growth in FTE. This finding might lead to another suggestion that ventures in the region of the university, making use of patents originating from that university, experience a significant growth in FTE in comparison with non-region ventures.

Table 7 gives information on the relationship of ventures with region and product development.

The cross table shows there is a small significant difference between ventures operating in the region and ventures that operated elsewhere. Ventures operating in the region spent more attention to innovative activities based on the patent in comparison to ventures not operating in the region. It might be possible that ventures operating in the region of the university feel more connected with the university and thus take the patent more serious. On the other hand, ventures participating in this research were often big companies and might have other incentives then regional companies of having patents of universities. Based on Table 6 and Table 7 it can be concluded that H3 is partly supported. There is no evidence for a growth in FTE in the region, though, attention is spent on innovative activities within these ventures in the region.

Table 6. *Relationship between venture in region and increase in FTE*.

Cells contain - Row percent - Weighted N		Increase in FTE		ROW Total
		Yes	No	
Venture in region	Yes	3 50,0%	3 50,0%	6 100,0%
	No	3 37,5%	5 62,5%	8 100,0%
	COL Total	6 42,9%	8 57,1%	

Table 7. *Relationship between venture in region and product development*.

Cells contain - Row percent - Weighted N		Development of product based on patent		ROW Total
		Yes	No	
Venture in region	Yes	5 83,3%	1 16,7%	6 100,0%
	No	4 50,0%	4 50,0%	8 100,0%
	COL Total	9 64,3%	5 35,7%	

The last hypothesis states that firms using patents of the University of Twente are positively related to receiving finance from venture capitalists. Table 8 gives an overview of how these variables are related to each other. The percentage of ventures that actually used the patent to receive finance is lower than the percentage that did not use the patent to receive finance of venture capitalists. Based on these numbers we can conclude that H4 is rejected.

Table 8. *Relationship between UT collaboration and receiving finance of venture capitalists*

Cells contain - Row percent - Weighted N		Used patent to receive loans		ROW Total
		Yes	No	
Patent based on collaboration with university	Yes	2 40,0%	3 60,0%	5 100,0%
	No	2 22,2%	7 77,8%	9 100,0%
	COL Total	4 28,6%	10 71,4%	

4.2 Patent valuation at the University of Twente

The University of Twente has been patenting inventions since decades; however, these were not registered by any of the departments and were paid from different budgets in the organization. Since 2007, just before the business development team started its activities, the university started registering patents more officially. The amount of patent requests, costs of first application and PCT[4] costs are therefore now comprehensible.

Figure 4. *Number of patents applied since 2007*

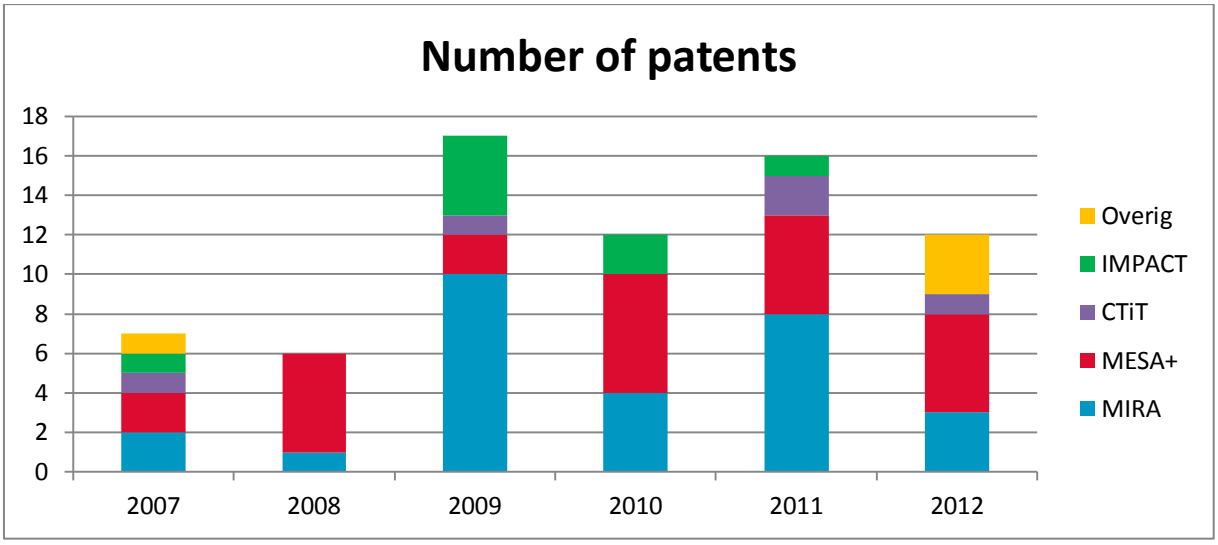


Figure 4 gives an overview of patent applications of University of Twente since 2007. Between 2000 and 2007 there were approximately 2 to 3 patent applications each year. Since the university started registering patents, a significant growth in the amount of patent

[4] The PCT makes it possible to seek patent protection for an invention simultaneously in each of a large number of countries by filing a single "international" patent application instead of filing several separate national or regional patent applications. (WIPO.int, 2013)

applications can be seen. An overview of the costs of patent applications is provided as well, however, this overview cannot be shown in this report because many patents on the list are not published yet, and are therefore confidential. The cost of the applications differs from €80,- to €18.179,14. There is a huge difference between these amounts, even though this does not say anything about the chance of success. It might, for example, be possible that the patent with low application costs (say €80,-) is sold sooner and has a high rate of return in comparison to the patent priced €18.179,14. Still, the University of Twente continues to patent inventions without applying a patent valuation after an invention. Patent valuation would help reducing unnecessary costs and would effectively help raising socio-economic impact of the patents.

5. Conclusion and discussion

The purpose of this study is to determine the socio-economic impact of the University of Twente's patents created during the period of 2000 till 2010. According to Baron (1993), Mueller (2005), Capello and Campagni (1998) and Haessler et al. (2009), patents are expected to be positively related to socio-economic impact. According to them, patents raised from universities have a positive impact on labour, level of innovation, regional prosperity and venture capital financing in society.

In this study, the first hypothesis was that patents created at the University of Twente are positively related to employment in the ventures that acquired university's patents. This is supposed to be so, because in most cases the patent ends up in a spin-off firm or is licensed to a bigger company. In both cases jobs are created Baron (1993), Parker and Zilberman (1993), Shane (2004). In this study it seemed that there are not enough significant findings to support this hypothesis. The data showed there is a small increase in employment, however, this increase was not enough to confirm a significant relationship. These results are in contrast to the results of Baron (1993), Parker and Zilberman (1993) and Shane (2004). The survey measured this growth in the period of January 2011 to November 2012. The economic financial crisis was highly influential during this period and many companies were shrinking to save costs because of the crisis. The data shows that the amount of FTE remained the same in this period. It is hard to estimate whether the new jobs which were created are related to the patent. It was not asked clearly in the survey, whether this was the case. This could be one of the explanations for the conflicting results. Next to this, the measurement period of 2011 till 2012 might be too short in order to assess employment growth. The results of a measurement over a period of a minimum of 3 years would probably be more realistic. The vague phrase which was used in the survey on FTE and the short term measurement might play a big role in the results. Because of this, this hypothesis is not rejected yet, it will instead be set on hold.

The second hypothesis that was tested was that ventures owning patents that were created at the University of Twente, which are actively involved in product development are also actively involved in process development. To answer this hypothesis, the level of innovation of these ventures was measured. According to Audretsch (1995); the higher the level of innovation, the less likely an innovative venture will collapse, and according to Mueller (2005) universities are a source of innovations.

This study showed significant findings to which support the hypothesis. Ventures that were active in product development based on the patent were also active in process development. We can therefore conclude that the innovation level of these ventures has increased based on the patent of the University of Twente. The likeliness of going bankrupt has therefore been decreased.

The third hypothesis suggests that spin-offs that own patents of the University of Twente in the period of 2000 till 2010 are positively related to employment and innovative activities, and therefore contribute to regional prosperity. According to Goldstein et al. (1995) spin-offs play an important role in regional economic growth by creating jobs and showing high rates o survival and growth. Spin-offs have other strengths as well; they transfer existing know-how of universities to the industry. The results show that the hypothesis is partly supported. Only half of the spin-off companies experienced growth in FTE. It is remarkable that mainly ventures that were operating outside the region experienced growth in comparison to these spin-off companies. An explanation for this could be the impact of the financial crisis. Ventures operating outside the region are usually firms that already existed. It seems that, during this difficult period, it is unusual for start-up firms to increase their level of FTE. However, looking at the results concerning the level of innovation, the spin-off ventures (regional ventures) show a higher level of innovation than ventures that do not operate in the region. An explanation could be that the budget of spin-off companies is too small to have a portfolio and therefore utilize the patents they have. They deepen their specialism and their level of innovation.

This study concludes with examining the fourth hypothesis. It states that firms using patents of the University of Twente are positively related to receiving finance from investors. Haessler et al. (2009) claim that today's investors seek certainty, and see a patent portfolio as something they can rely on. It even decreases the information asymmetry that occurs between entrepreneurs and investors. However, these assumptions are not confirmed in this study. Just a low percentage of firms was financed by investors because they owned patents of the University of Twente.

Based on these results one can conclude that the patents of the University of Twente have a socio-economic impact in different ways. The patents contribute by increasing the level of innovation in the industry and stimulate regional prosperity. These results are in accordance to the vision of the University of Twente. After all, in their strategic vision the University of

Twente states that socio-economic development, especially with a focus on innovation, plays an important role in their strategic positioning. It seems that they have achieved their purpose. Next to this, there was a small growth in FTE noticeable too. Unfortunately this study was not able to show that this growth was significant. The limited survey, which was developed by NL Octrooicentrum, might play a role here. Some questions were interpreted in different ways by respondents. This was especially apparent regarding the various answers to open questions, which showed no consistency. Another disadvantage of the survey was that it contained many different scales. This construction was a barrier for applying statistical tests like regressions or correlations.

The University of Twente partly achieved their goals as shown in Route '14. In order to be more effective technology transfer must receive more attention from the board. It is a good sign that since 2010 the business development team arose which deals with the regulation of patents, tracks the patent applications and finds potentials to take over the patent. It is time to apply the strategies, as given in Route '14, in this department as well. An important element would be to apply patent valuation in order to decrease costs and increase the socio-economic impact.

For further research it would be useful to perform the research again and try to achieve a higher percentage of responses for the University of Twente. In order to raise responses it might be useful to send the survey to the inventor of the patent instead of to the firms. Often the inventor is more involved with what happened to the patent and is more willing to participate in researches. Other indicators could be added to the study as well. However, it has to be taken into account, that when using indicators in a study, it is important to determine their usefulness. Not every indicator is easy to measure because some are qualitatively based. Even if the indicator is quantitative, it can happen that one cannot easily compare scores. For example, if University of Twente developed 4 patents for the industry and Delft University developed 3, one cannot say that the University of Twente did a better job, because Delft University may have developed patents of better quality. Therefore the number of patents can give a biased view of the situation.

On the other hand, there can be doubts about using indicators and about how to use the term valorisation. As mentioned earlier in this study, it is difficult to define socio-economic impact and even the term valorisation is not concrete. The purpose of this study is to determine the

value contribution of patents in practice. There still is no concrete definition in government studies used to measure this with consistency, while in the financial world patent valuation has been applied several times and is defined properly. The definition of patent valuation and the different methods of how to value patents could give insight on how patents are related to socio-economic impact. When applying patent valuation as an element in measuring socio-economic impact the results will be more consistent.

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Appendix

Appendix A. Contextual factors

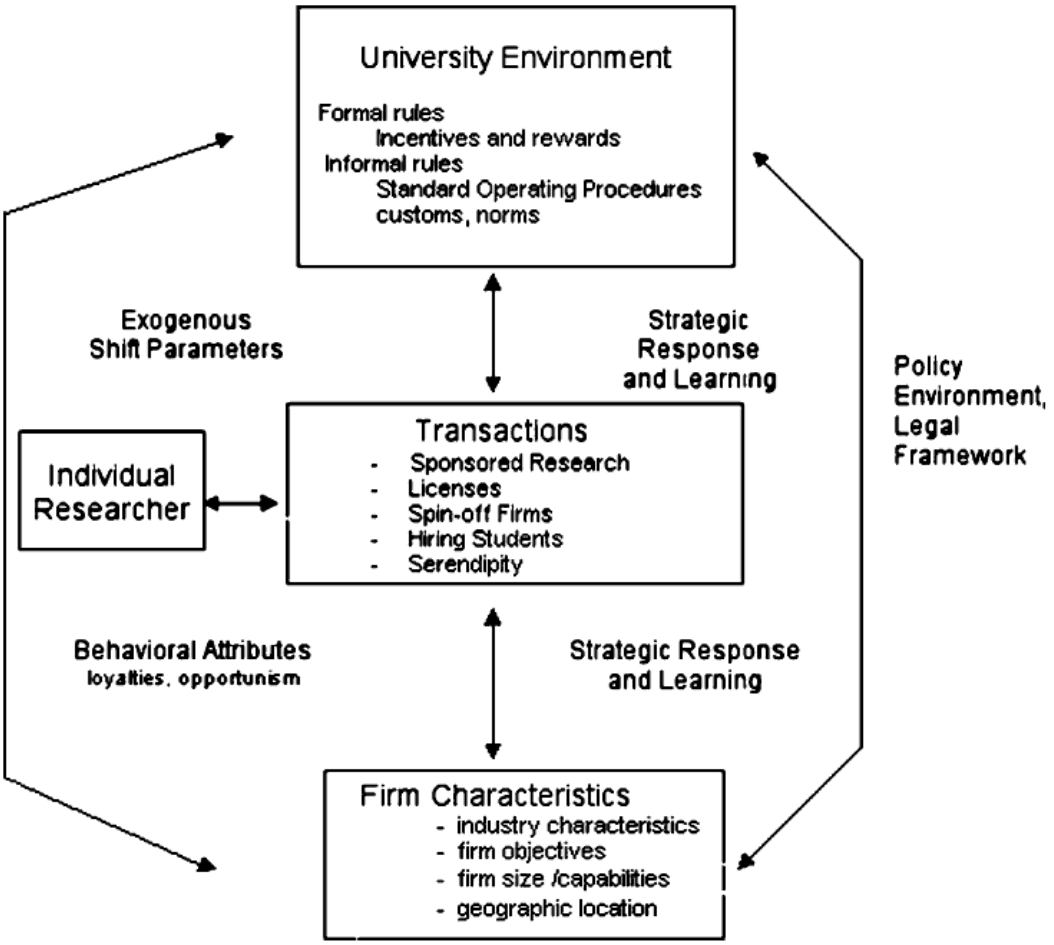

Figure 1. University–industry relationship evolutionary schema.

Appendix B. Questionnaire

Questionnaire ; RIS & IP Based entrepreneurship (2012)
De vragen in deze vragenlijst hebben betrekking op het octrooi:
*** TITEL ***
*** NUMMER ***
*** PUBLICATIEDATUM ***
*** UITVINDER ***

De eerste vragen gaan over de wijze waarop u het octrooi geëxploiteerd heeft.

		Ja	Nee
1	Heeft U het octrooi opgenomen in een pakket van gerelateerde octrooien en/of vindingen ?		
2	Komt het octrooi voort uit samenwerking en/of contractonderzoek met de universiteit?		
3	Heeft u met het octrooi een product kunnen ontwikkelen, een standaard kunnen zetten of soortgelijk?		
4	Heeft u met het octrooi een proces kunnen ontwikkelen?		
5	Heeft u met het octrooi een (niche-) markt kunnen ontwikkelen?		
6	Heeft u met het octrooi een exclusieve markpositie kunnen verkrijgen?		
7	Heeft u op het octrooi een (sub-) licentie aan derden verleend?		
		Hoeveel licenties?	
8	Heeft u het octrooi gebruikt om financiering te verkrijgen?		
9	Heeft u het octrooi gebruikt om aan te tonen hoe innovatief uw bedrijf is?		
10	Heeft u het octrooi gebruikt om onderhandelingen in kruislicenties?		
11	Heeft u het octrooi gebruikt om te voorkomen dat anderen u beletten om toe te treden tot een (niche-)markt?		
12	Heeft u het octrooi gebruikt om anderen te beletten om octrooi aan te vragen voor deze vinding?		

Indien ja:
Vraag 21 t/m 32 beantwoorden

Wilt u voor elk van de exploitatiewijzen van het octrooi aangeven hoe belangrijk u die wijze vindt. Dus voor de vragen 1 t/m 12 waar u "Ja" heeft geantwoord, de vragen 21 t/m 32 beantwoorden.

Hoe belangrijk vindt u de wijze waarop u het octrooi heeft geëxploiteerd op een schaal van 1 tot 7, waarbij 1 is heel onbelangrijk en 7 is heel belangrijk. *(Het door u gewenste cijfer graag **vetgedrukt** maken)*

	1: Heel onbelangrijk						Heel belangrijk: 7
21. Pakket octrooien	1	2	3	4	5	6	7
22. Samenwerking universiteit	1	2	3	4	5	6	7
23. Product e/o standaard	1	2	3	4	5	6	7
24. Proces ontwikkelen	1	2	3	4	5	6	7
25. Markt ontwikkelen	1	2	3	4	5	6	7
26. Exclusieve marktpositie	1	2	3	4	5	6	7
27. Licentie aan derden	1	2	3	4	5	6	7
28. Financiering	1	2	3	4	5	6	7
29. Innovatief imago	1	2	3	4	5	6	7
30. Kruislicenties	1	2	3	4	5	6	7
31. Toetreding beletten	1	2	3	4	5	6	7
32. Beletten octrooiaanvraag	1	2	3	4	5	6	7

41. Als u alle vormen van exploitatie van het octrooi bij elkaar optelt. Hoeveel uur is er binnen uw bedrijf besteed aan dit octrooi, in manuren?

_____ manuur

Indien u het niet precies weet, welke van de onderstaande categorieën is dan van toepassing? *(Het door u gewenste antwoord graag **vetgedrukt** maken)*

a. 0 uur
b. minder dan 480 manuur
c. minder dan een manjaar
d. 1 tot 4 manjaar
e. 5 manjaar of meer
f. weet niet

42. Wat zijn de inkomsten voor uw bedrijf geweest die zijn toe te rekenen aan het octrooi?

_____ Euro

Indien u het niet precies weet, welke van de onderstaande categorieën is dan van toepassing? *(Het door u gewenste antwoord graag **vetgedrukt** maken*)

a. Geen inkomsten
b. minder dan 30.000 euro
c. 30 tot 100.000 euro
d. 100.000 tot 1 miljoen euro
e. meer dan 1 miljoen euro
f. weet niet

43. Heeft uw bedrijf octrooien in portefeuille, die niet uit universitair onderzoek voortkomen, maar door eigen R&D inspanningen? *(Het door u gewenste antwoord graag **vetgedrukt** maken*)

a. ja
b. nee

44. (Indien vraag 43 = ja)
Welke octrooien leidden voor uw bedrijf tot de hoogste inkomsten: uw "eigen" octrooi of het "universitair" octrooi. *(Het door u gewenste antwoord graag **vetgedrukt** maken*)

a. eigen octrooi
b. universitair octrooi
c. (ongeveer) even veel
d. weet niet

45. Hoe veel medewerkers (uitgedrukt in full time equivalenten) heeft uw bedrijf nu?

_____ medewerkers

46. Hoeveel medewerkers (uitgedrukt in full time equivalenten) had uw bedrijf per 1/1/ 2011?

_____ medewerkers

47. Hoeveel medewerkers binnen uw bedrijf werken aan R&D ?

_____ medewerkers

48.Wat was de omzet van uw bedrijf in 2011? *(Het door u gewenste antwoord graag **vetgedrukt** maken*)

a. minder dan 100.000 euro
b. 100 – 250.000 euro
c. 250 – 500.000 euro
d. 500.000 tot 1 miljoen euro
e. meer dan 1 miljoen euro
f. weet niet

49. Wilt u de resultaten van deze enquête ontvangen ? *(Het door u gewenste antwoord graag **vetgedrukt** maken*)

a. ja
b. nee

50. Eventuele opmerkingen of andere relevante informatie, die u niet in uw antwoorden kwijt kon.

Appendix C. Increase in FTE in relation with turnover of the firm

Table 4. *Increase of FTE in relation with turnover of the firm.*

			Increase in FTE		Total
			Yes	No	
Turnover of firm	Less than 100.000 Euro	Count	0	2	2
		% within Turnover of firm	0,0%	100,0%	100,0%
	100.000 - 250.000 Euro	Count	1	0	1
		% within Turnover of firm	100,0%	0,0%	100,0%
	More than 1.000.000 Euro	Count	5	6	11
		% within Turnover of firm	45,5%	54,5%	100,0%
Total		Count	6	8	14
		% within Turnover of firm	42,9%	57,1%	100,0%