CATÓLICA LISBON

SCHOOL OF BUSINESS & ECONOMICS

UNIVERSIDADE CATÓLICA PORTUGUESA

Trademarks as an Indicator of Innovation Implementation – Evidence from the German Pharmaceutical and IT-Service Industries

Harm-Julian Schumacher

152113102

Dissertation submitted in partial fulfilment of the requirements of the degree of International MSc in Business Administration at Católica-Lisbon School of Business and Economics

5th of January 2016

Abstract

This paper examines the potential application of trademarks as a complementary indicator of innovation. Recent innovation literature finds a correlation between innovation and usage pattern of trademarks. Especially for the service industry this new approach offers potential since R&D and patents indicators do not capture innovation in these sectors. To understand the relationships between trademarks and innovation the German pharmaceutical and IT-service industries were studied. As a proxy for innovation sales and employment growth were introduced. The impact of filing a trademark was then compared with a control group and correlations with patents examined. The results show that trademarks indeed can be used as an indicator of innovation; however, with some limitations. While IT-service companies show a strong relationship between trademarks and growth, the results for the pharmaceutical industry are ambiguous and need to be further examined.

Table of Contents

Appendix Directory

Table Directory

Graphic Directory

Abbreviation Directory

BVDID	Bureau van Dijk ID (BVDID)
CTIM	Community Trademark (CTM)
CAGR	compounded annually growth rate (CAGR)
EPO	European Patent Office (EPO)
KIBS	knowledge-intensive business services
OHIM	Office for Harmonization in the Internal Market (OHIM)
SMB	small and medium business (SMB)
WIPO	World Intellectual Property Organization (WIPO)

1. Introduction

The understanding that innovation is an essential driver of economic growth is established in today's society. As Schumpeter (1939, p. 83) states "nothing can be more plain or even more trite common sense than the proposition that innovation is at the center of practically all the phenomena, difficulties, and problems of economic life in capitalist society". The importance of innovation is illustrated by various rankings like Forbes' world's most innovative companies ranking, the Global Innovation Index or Bloomberg's innovation index, which rank companies or countries by its degree of innovation. However, the measurement of innovation is still an ongoing discussion in the scientific community. Many different approaches have been developed and today R&D expenses, number of patents or patents citations are frequently used to determine the level of innovation in companies. A relatively new method is the application of trademarks as an indicator of innovation. The purpose of this paper is to determine the usefulness of trademarks to measure innovation based on empirical evidence from the German pharmaceutical and IT-service industry.

7 million trademarks applications have been filled in 2013, making them the most used form of intellectual property, even before patents with 2,6 million applications (WIPO, 2014). The enormous number demonstrates the significance as a tool for companies and the application of trademarks as an indicator of innovation is a logical consequence. The usage of trademarks offers two improvements over the current indicators. Firstly, trademarks are part of the effort of companies to make money with their products, services and inventions. While R&D can be viewed as an input into the innovation process and patents represent the output, none of these two indicators establish the connection between innovation and commercialization. Trademarks can help to overcome this gap since they are a crucial part of companies marketing activities (Krasnikov, Mishra and Orozco, 2009). Secondly, service industries are adversely affected by R&D and patent indicators because such intellectual property rights (IPR) are hardly used within these sectors. Hence, new indicators have to be developed in order to determine innovation for service compa-

nies. Trademarks seem to be a promising approach since they are equally used within all kind of industries.

In order to understand the usability of trademarks as a commentary indicator of innovation, this paper developed a new approach. While many studies tried to examine the usefulness by calculating correlation between trademark and patents or conducting surveys, none uses trademarks to measure the impact of innovation. This study attempts to overcome this gap by linking trademarks to growth statistics, which represents the outcome of successful innovation. Chapter 2 discusses the theoretical and empirical literature of trademarks and innovation. The legal background is outlined and relevant processes in order to obtain a trademark are explained. The legal part is followed by an overview of the current state of research about innovation indicators. Additionally, the bridge is build between innovation and growth statistics. Chapter 3 covers the empirical part of this paper. The data sources and specification are presented and the applied methodology of the empirical work explained. The second part of chapter 4 is split into descriptive and growth analyses and discusses the results obtained by the empirical analyses. This cover sales as well as employment growth. Chapter 5 concludes the paper, summarizes the empirical findings and discusses potential application of trademarks as a commentary indicator of innovation.

2. Theoretical and Empirical Discussion of Trademarks and other indicators of innovation

In order to examine the usefulness of marks as an indicator of innovation, one has to firstly understand the original purpose of trademarks, its evolution as well as today's legal background and the rights, which are granted.

2. 1 Trademark as an intellectual property right

The first evidences of marks are found 5.000 BC as an identifier for the ownership of livestock. Over the centuries the purpose evolved and during the Roman Empire a bricks bored the marks of its manufacturer in order to serve as a designation of the producer and his obligation for quality. With the advent of industrialization trademarks became more relevant for the economy and hence a number of explicit trademark laws were issued in France (1857), the United Kingdom (1862), the United States (1870) (Mendonça, Pereira and Godinho, 2004). According to the Supreme Court of the United States in 1871 the purpose of a trademark “is to identify the origin or ownership of the goods to which it is affixed” and that this origin or ownership must be of a personal nature (Schechter, 1927, p. 814).

In today’s economy, however, the origin rarely plays a role in consumer decisions. The World Intellectual Property Organization (WIPO) defines a trademark as a “distinctive sign, which identifies certain goods or services as those provided by a specific person or enterprise” (WIPO, 2004, p. 8). The definition implies two essential objectives of trademarks, namely protection and dissemination. These two indistinguishable functions of trademarks grant company exclusive rights to mark its products and at the same time prohibit other parties to use the same trademark. Combining the functions allows customers to use trademarks as an identifier for customers to assign a level of satisfaction to a certain product and stimulate future purchases (Schechter, 1927). Hence, trademarks can be regarded as a marketing assets and are highly intertwined with brands (Aaker, 1991). This connection infers that “firms’ trademark activities capture a significant portion of their branding efforts” (Krasnikov, Mishra, and Orozco, 2009, p. 154). However, brands are not identical in value and the determination of this value depends on many factors. In management literature different sets are used, such as name awareness, customer loyalty, perceived quality and associations with the brand, that add value to the product being offered (Aaker, 1991). Economides is one of the first to examine the ‘Economics of trademarks’ and draws one important conclusion: a trademark should be filled when its expected revenues its the discounted costs. This means that companies only use brands if they expect a differentiation in the market from it and to extract returns (Economides, 1988).

From simple identifier of origin to complex indicators of satisfaction and revenue extraction tools, the evolution of trademarks demonstrates two important facts: 1) successful trademarks can be a highly valuable form of property of companies, even though they are intellectual respectively intangible assets of an organisation, 2) trademarks help to distinguish products from the ones of competitors and hence help providing an economical niche for organisations in competition (Hunt, Muncy and Ray, 1981). These features make trademarks an important tool of competition and assign them a key role in today's economy. Examining the usage of trademarks offers insights into the marketing activities and the willingness to protect its products. In contrast, patents transfer information about the technical knowledge of a company (Sandner and Block, 2011). The next part will explain the legal background of trademarks and the criteria to obtain one. Furthermore, differences compared to patents will be outlined.

2.1.1 Trademark Law

In the application process, certain legal requirements are checked and an examination of the aspired trademark takes place. Three main requirements have to be fulfilled in order to successfully register a trademark (European Council, 1993). The first and most important requirement is distinctiveness. Since the main purpose of a trademark is to identify products and its quality, a new trademark should not deceive or mislead customers. Similarity and conflict with other trademarks are hence forbidden. Secondly, a trademark should be able to graphically represent a company, respectively brand. Today various kinds of trademarks are allowed. The most used ones are word and figurative trademarks, but also sounds, colours, fragrances and 3D forms can be registered. Thirdly, a generic sign or word cannot be registered since the purpose of a trademark is to establish a direct link between a company and customers (WIPO, 2012).

The criteria for registering a trademark are in sharp contrast to criteria for patents. Patents are only granted to technical ideas on the basis of non-obviousness, inventiveness in the face of prior art and the potential for industrial application Besides the difference in the purpose, there are several other important legal requirements Firstly, the length of the period during which the exclusive rights are granted. While a patent normally expires after 20 years, a trademark can be renewed indefinitely. This renewal however, requires a regular fee and therefore makes it costly for companies to maintain a trademark (WIPO, 2004a). Furthermore, the law requires trademarks to be used and non-usage leads can lead to the cancelation of a trademark after a period of usually five years within the European Union (OHIM, 2014). Millot (2009) finds evidence that many trademarks are actually not use and cancelled after a period of six or seven years.

The time between filing and finally obtaining a trademark it is much smaller compared to patents. Successfully registering a trademark in Europe normally takes up to one year. In contrast the process for a patent can last as long as five years. Moreover, the usage of a trademark is not linked to the filings. Companies can use trademarks before or directly after the filing and the registration is a requirement only for protection against the usage of others (WIPO, 2004a).

The first international trademark agreement was reached at the Paris convention 1883. Its main outcome was that foreign applicants enjoy the same rights as local holders. Today the WIPO, which emerged from this conference, facilitates Intellectual property rights on the global scale. In the Europe Union the Office for Harmonization in the Internal Market (OHIM) was established in 1994 and with it the Community Trademark (CTM), which allows simultaneous registering of trademarks in all European countries and provides a relevant and complete database (Mendonça, Pereira, and Godinho, 2004).

The next chapter demonstrates how brands and trademarks interlink with the theory of innovation and how they might be used to measure innovation in organisations.

2.2 Indicators of Innovation at the Company Level

The key players in the innovation process are business enterprises. Their combination of short-term abilities and long-term vision make them the main driver of technological change (Chandler, 1994). The innovation process is defined as a learning process that generates or acquires new knowledge with the ultimate goal to utilise this knowledge and create an economic value (Witt, 1993). It can be split into two parts: economic creativity and innovation implementation (Williams and McGuire, 2010). Economic creativity is ‘‘any form of creativity that results in codified knowledge with potential economic value’’. However, Innovation ‘‘goes beyond’’ creativity and implementation is a central part of it. Only put together innovation occurs and each part requires different measures and indicators (Guerrero-Cusumano and McGuire, 2001).

The measurement of innovation activities in companies is highly complex and to pinpoint effects and relevance is a difficult undertaking, which is aggravated by economic, social, technological and organisational interdependences (OECD, 1992). In order to be a suitable indicator several requirements have to be fulfilled: 1) a significant correlation between the indicator and innovation has to exist 2) the number of applications has to be sufficiently high in order to achieve statistically relevant results 3) the indicators has to be electronic accessible 4) a partition along various factors is crucial 5) An international comparison should be possible (Schmoch, 2003). Until this point various indicators have been developed and used to measure innovation on a firm level.

Like the innovation process itself, its indicators can be divided into the two groups: economic creativity and innovation implementation. Economic creativity can be further divided into input and output driven indicators. R&D expenditures are mainly used to measure innovation input, while output and its quality is measured through the number of patents, respectively the number of citations a patent receives. R&D is understood as an investment activity of companies into its ‘knowledge stock’ and can thus be used as a proxy to understand how much companies invest into its innovation capabilities (Hall, Jaffe, and Trajtenberg, 2005).

Patents are the output of the R&D activity of companies. Pakes and Griliches (1980) were able to prove this strong relationship between R&D and patents. Across various firms and industries they demonstrate a company can change its inventive output (patents) by adjusting the input (R&D). As a first approach on a macro scale, the number of patents per company has been used as an indicator (Griliches, 1984; Scherer, 1965; Schmookler, 1666). Using only the number of patents, however, is inherently limited since patents vary extremely in their value and technological importance and hence, further indicators were developed. A first step towards understanding the heterogeneity of patents was the examination of renewal rates by Pakes and Schankerman (1984), which demonstrated obvious differences in patents. In order to determine the importance of patens, citations were revealed as the obvious mean to achieve this goal. Trajtenberg (1990) and Albert, Avery, Narin and McAllister (1991) were the first among other to follow this new path to classify patents and thus derive better results and more meaningfulness from patent data. The citation approach conveys two major implications of innovation. Firstly, citations allow to link inventions and its distribution over the world and influence on new inventions. Secondly, it allows assigning ‘values’ to patents and thereby differentiating between patents and its importance (Hall, Jaffe and Trajtenberg, 2005).

Even though R&D remains the stronger indicator for market values, several studies examined the usage of citations as a determinant of the market value. While (Hall, 2000) finds that the explanatory power is lower compared to R&D expenses, patents still add useful information above and beyond R&D. Hall, Jaffe and Trajtenberg (2005) demonstrate that patent citations can be used as a complementary indicator besides R&D. Citations are more correlated to R&D than simple patent counts and including them into market value equations increases the predictive power of a Tobin’s q analysis.

While R&D and patents respectively patent citations provide interesting insights about invention in companies and their technical level, its explanatory potential is limited. Both do not offer insights into commercial aspects of innovation and it is thus questionable if all relevant areas are covered. Looking at Williams and McGuire (2010) definition of the two folded innovation process, only economic creativity is taken into account and innovation implementation left untouched by R&D and patent indicators. Overall, there is no single indicator which can fully reflect innovative activity and its results (Malmberg, 2005).

Hence, further proxies have to be developed and combined with the existing ones in order to tackle shortcomings. A new promising approach is to use registered trademarks. Trademarks in particular are an indicator of innovation implementation (Williams and McGuire, 2010) and the next part discusses previous studies and the usefulness of trademarks from a theoretical point of view in order to measure innovation.

2.3 Trademarks in Innovation Research

Examining the current innovation research, theoretical as well as empirical justification for the usage of trademarks as an indicator can be found. Surveys across various industries have found that companies use different means to protect their innovations and extract returns. A common finding of all the studies is that only in a few industries patents are used as the major tool to protect innovation only. Other tools such as secrecy, lead time or exploitation of reputation are used and especially marketing activities and assets play a significant role and are widely spread along various industries (Cohen, Nelson, and Walsh, 2000; Levin. Klevorick,Nelson and Winter, 1987). The importance of marketing, and hence trademarks, is confirmed when examining the associated costs of launching an innovation. Pavitt (1985) concludes that half of the expenditures are linked to R&D activities and the other half to production, engineering and marketing.

While not every trademark is linked to a new or innovative product or service Mendonça, Pereira and Godinho (2004) are able to connect innovations studies and trademarks using an economic rational. They argue that trademarks need to have an expected positive net present value in order to be filled. Only if the new product offers a substantial differentiation, a trademark is filled because sufficient profits can be generated. Hence, trademarks connected to an innovation represent the majority of filings. Furthermore, Mendonça, Pereira and Godinho conclude that trademarks are registered only shortly before the launch of a product, indicating a later phase in the innovation process compared to patents.

Following the arguments of Mendonça, Pereira and Godinho (2004) trademarks help understanding the last step in the innovation process, namely the innovation implementation, due to its connection to marketing efforts of companies (Hipp and Grupp, 2005). Companies launching new innovations, associate it to a new brand and apply for a new trademark to foster the perception by consumers (Millot, 2009). Therefore, it seams reasonable that companies only apply for new trademarks, when they launch major upgrades to inform the customers and not for minor enhancements (Malmberg, 2005). Combining the arguments above, one can conclude that the registration of a trademark indicates an innovation new to the firm, either in form of a major upgrade or as a new product or service.

Considering practical arguments, there are several advantage using trademark data as an indicator. Firstly, the available data is beneficial since trademarks have been recorded regularly and systematically for decades in many countries. Secondly, they fulfil all requirements for a statistical indicator: high number available, electronically accessible, divided by sector and widely spread all over the world, enabling international as well as cross-industry comparison (Millot, 2009).

2.3.1 Empirical Studies of Trademark Innovation

There are also several empirical studies examining the connection between innovation and trademarks. (Allegrezza and Guard-Rauchs, 1999) examine the connection between innovation, proxied by R&D intensity, and trademarks of 2.500 Benelux SMEs. They are able to prove a significant positive relation. Schmoch (2003) finds similar results for the European manufacturing sector, namely a strong correlation between the usage of trademarks and patents. Results from the third Community Innovation Survey (CIS) delivers further evidence regarding the usage of trademarks and patents by innovative firms. Across various European countries, the survey rates companies along their innovativeness and ask about the usage of IPRs. In general, the usage of trademarks is more widely spread than patents, which is logical due to the stricter legal requirements. Moreover, the survey demonstrates that innovative firms use more trademarks and patents than in non-innovative firms (Lucking, 2004). These results are confirmed by Mendonça, Pereira and Godinho (2004) in their study about IPRs and in particular trademark usage. The evidences from Portugal also suggest that companies, which use one form of IPR, also tend to use other IPRs.

An exploration of the Swedish electromechanical, automotive and pharmaceutical industries between 1945 and 1996 delivers ambiguous results. One the one hand trademarks are unreliable as an indicator in the automotive and electromechanical industry due to the inconsistent usage. Companies often use model numbers instead of trademarks to identify products and hence limit the explanatory power of trademarks. Swedish pharmaceutical companies on the other hand have been a frequent user of trademark for a long time. Firstly, a high percentage of new products have been trademarked. Secondly, the number of new trademarks has a significant long-term correlation with the filing of new drugs. Furthermore, a correlation between patents and trademarks in discovered; however, patents follow a 20-year peak interval while trademarks follow a 10-year peak interval. This lead to the conclusion that the combination delivers interesting results regarding innovations studies and that trademarks are able to more short-term insight beyond the insights gained from patents (Malmberg, 2005).

Only few studies examined the relationship between trademarks and economic performance of companies; however, these ones were able to find a positive a correlation. Griffiths, Jensen and Webster (2011) use trademark deposits, patents and industrial designs as an indicator of innovation and examine the influence on the growth of profits. They conclude that trademarks have a positive impact; however, not as strong as the one of patents and designs. Greenhalgh and Rogers (2012) find a similar relationship between trademark and a company's stock value. It can be inferred that trademarks act as a proxy for unobservable characteristics that raise productivity. Seethamraju (2003) finds a positive correlation between trademarks and sales and are able to link the correlation to increased market values of companies. Krasnikov, Mishra, and Orozco (2009) evaluate the impact of trademark filings on the financial performance of companies. Distinguishing between brand-identification and brand-association trademarks, they find a positive relation between the filing of a brand-association trademark and a firm's stability and size of cash flows, Tobin's q, ROA and stock returns. However, the affect of filings diminishes with increasing customer brand awareness.

2.3.2 Trademarks in the Service Industry

Trademarks as an indicator of innovation are in the service industry are emphasised for two reasons: Firstly, the importance of the service sector for the economy has constantly risen over the last decades (Arundel, Kanerva, Cruysen and Hollanders, 2007; OECD, 2005) and examining innovation in the tertiary sectors becomes increasingly important. Secondly, the definition of appropriate innovation indicators for services is difficult (Djellal and Gallouj, 1999)and patent and especially R&D measures have proven to be especially disadvantageous for the service industry (Hipp and Grupp, 2005). Hence, the development of new indicators is essential.

Various studies examine the potential usage of trademarks as indicator in the service industries and provide interesting results. A study by Hipp and Grupp (2005) confirms that innovation in services is different to innovation in other areas and hence, must be handled in a different way. A special emphasis is put on knowledge-intensive business services (KIBS), because these companies facilitate innovations in other economic sectors as well as drive innovation in other companies (Hartshorn and Wheeler, 2002). KIBS sectors include computer services, R&D services, legal, accountancy, management services, architecture, engineering, technical services, advertising and market research (Miles, 2005). CTM application data shows that KIBS classes are among the classes which mostly sought trademark protection between 1996 and 2002 (Mendonça, Pereira and Godinho, 2004).

Examining the correlation between trademark and innovation success in KIS and KIBS a particularly strong and statistically significant correlation is found. The explanatory power is especially high for product innovations and trademarks are likely to be a suitable indicator of innovation in these sectors (Gotsch and Hipp, 2012). Schmoch (2003) finds a significant correlation between trademarks and the level of innovation, which is represented by the share of revenues with new products and services. As a next step subsectors were defined, namely technology-oriented services and knowledge-intensive services (KIS). While KIS companies have a significant correlation (5%) with marks and a low significant correlation with patents (10%), the opposite is true for technology-oriented services with a highly significant (1%) correlation with patents and a low significant correlation with trademarks (10%).

After confirming the usefulness of trademarks as an indicator of innovation in services through theory and practical evidence, the next chapter connects innovation and growth statistics in order to measure innovation within companies.

2.4 The Link between Innovation and Growth

A major difficulty in observing innovation in growth statistics is the time lag between developing an invention and transforming it into measurable economic performance. Especially the long way from R&D as innovation input over patents as output of economic creativity to the commercialisation makes it difficult to link both indicators to sales or employment growth (Coad, 2009). Companies have to undertake product development or may even delay this willingly (Bloom and Van Reenen, 2002). However, trademarks are only filled shortly before launching a new product and cover the commercialization of innovation. Hence, they may overcome the time problem and provide an instant link between innovation and growth.

In the following sales and employment growth are analysed separately since sales growth is an output and employment growth and input.

2.4.1 Sales Growth

A McKinsey Global Survey of Business Executives states that “[e]xecutives overwhelmingly say that innovation is what their companies need most for growth” (Carden, Mendonca, and Shavers, 2005, p. 17). Another survey examining SMEs find out that the most important strategy for expansion is investment in product innovation (Hay and Kamshad, 1994). While in economic theory innovation has been identified as a central aspect of sales growth (Klette and Griliches, 2000), finding empirical evidence is challenging.

Mansfield (1962) undertook on of the first attempts by examining the steel and petroleum industries. Over a 40-year period he concludes that innovators grew more quickly, especially if they were small. Geroski and Machin (1992) provide similar results when looking at large quoted UK firms. Innovators are more profitable and grow than non-innovative firms. Another study compares patents and sales growth within the 365 large US corporations. It can be determined that the patents positively influence sales growth and subsequently profits growth (Scherer, 1965). The influence of R&D on sales growth is studies by (Mowery, 1983) in the US manufacturing industry between 1921 and 1946. Only between 1933 and 1946 a positive influence of R&D is observed and no difference between small and large companies can be determined. Roper's (1997) observations of small companies from the UK, Ireland and Germany show that a contribution by innovative products to sales growth.

Overall, it can be determined that patents and R&D have several limitations when using them to measure sales growth. R&D is an innovation input and normally relatively smoothed over time. Patents have a skewed value distribution as well as a long time to market. These drawback result in a poor usage as indicators of innovation (Coad, 2009). To tackle this shortcomings, Coad and Rao (2008) create a variable to simulate innovativeness combing R&D and patents. The results challenge the importance of innovativeness for sales growth and rather determine that it is only crucial for a few high-growth companies. Similar results can be found in the pharmaceutical industries, where few blockbuster drugs generate huge profits, but median drugs have a negative net present value below R&D expenditures (Grabowski, Vernon, and DiMasi, 2002).

2.4.2 Employment Growth

The impact of innovation on employment growth is considered two-folded in literature. One the one hand process innovation goes along with an increase in productivity and may lower the required amount of labour. On the other hand product innovations are associated with employment increases. Hence, a differentiation between product and process innovation takes place in the recent innovation research. The impact of process innovation will be disregarded for the purpose of this study, since it can be assumed that trademarks are rarely filled for process innovations and that product innovations represents the majority of applications. Furthermore, indirect effects between the different forms of innovation on employment will be ignored.

Looking at product innovations studies, many find a positive correlation with employment. Brouwer, Kleinknecht, and Reijnen (1993) examine product related R&D expenditures and prove a small positive effect on employment. Similar results are confirmed by Van Reenen (1997) and (Smolny, 1998) for manufacturing companies from the UK and Western Germany, respectively. A study in four European countries (France, Italy, the UK and Germany) between 1998 and 2000 examines manufacturing as well as service industries. While process innovation appears to have a negative effect, product innovation is associated with employment growth in companies (Harrison, Jaumandreu, Mairesse and Peters, 2014). Overall, the evidence presented suggests a correlation between product innovation and employment growth, which will be tested in the following chapter.

3. Empirical Analysis

After providing a theoretical and empirical foundation the next chapter covers an empirical approach to understand the relationship between trademarks and innovation. Chapter 3.1 outlines the data used for this paper and chapter 3.2

explains the method used to gain further insights. Chapter 3.3 summarises the achieved results and differentiates between descriptive and growth statistical analysis.

3.1 Data

This paper brings together three different data sources: 1) trademarks data, 2) patent data and 3) economic company data. The following chapter will describe the different data sources as well as the preparation of the data that took place in order to perform different statistical analysis.

For international comparable trademark statistic, the OHIM database was used. While it is biased towards European companies, it offers many analytical advantages. Firstly, all trademark applications are evaluated the same way and no combination of different criteria takes place, which happens when combining different data sources. Secondly, the OHIM data is freely available and presents a huge amount of comparable data. In particular the information regarding the status of the trademark, its filing, registration as well as expiry date and the kind of trademark are relevant for the statistical analysis. Overall, the database consists of 1.077.613 trademark applications between the years 1996 and 2013. Table 1 demonstrates the different status of the applications for a CTM.

Status	Frequency	Percent
Appeal pending	455	0,04
Application opposed	10.599	0,98
Application published	401	0,04
Application refused	38.595	3,58
Application under examination	93	0,01
Application withdrawn	98.208	9,11
Registered	801.959	74,42
Registration cancellation pending	2.172	0,2
Registration cancelled	1.532	0,14
Registration expired	120.195	11,15
Registration pending	67	0,01
Registration surrendered	3.337	0,31
Total	1.077.613	100

Table 1: Trademark status of complete OHIM database

The most frequent status are ‘Registered’, ‘Registration expired’, ‘Application withdrawn’ and ‘Application refused. Table 2 demonstrates the different types of the whole database.

Type	Frequency	Percent
3-D	6.935	0,64
Colour	813	0,08
Figurative	416.142	38,62
Hologram	9	<0,00
Olfactory	7	<0,00
Other	634	0,06
Sound	200	0,02
Word	652.873	60,59
Total	1.077.613	100

Table 2: Trademark features of complete OHIM database

The most frequent used types of trademarks are word and figurative trademarks representing over 99% of the different trademark types.

The company information are provided by the Bureau van Dijk database. Based on the Bureau van Dijk ID (BVDID) various information are assigned to a company, namely the foundation date, the last information date, sales and employment information between the years 2005 to 2014 and the NACE classification. The NACE information has advantages over the NICE classification of trademarks, because it more detailed with 615 classes compared to 45 classes. Furthermore, it assigns each company specifically to one industry, while a trademark can have several NICE classes. Regarding the company information it is important to know that the sales and employment data is not available for each year for each company (see table 3).

Group	**Industry**	**Sales Growth Data** (min. 1 observation)	**Emp Growth Data** (min. 1 observation)	**No Growth Data**
Trademark Group	Pharmaceutical	208	266	26
	IT-service	682	1104	266
	Overall	890	1817	292
Control Group	Pharmaceutical	63	95	37
	IT-service	149	224	62
	Overall	212	319	99

Table 3: Overview of available growth data

Only 292 companies in the trademark group and 99 companies in the control group neither have sales nor employment data (taking into account the calculations of a CAGR, see chapter 3.2 Methodology).

As a next step the CTM data and company data is merged using the 'OHIM-BVDID' table, which assigns each trademark application to the respective company. By keeping the complete merges as well as the incomplete ones (containing only companies without trademark applications) a database with two groups is created. Firstly, firms which applied for trademarks and have available economic information (merge = 3, called 'trademark group' / control = 0) and secondly, companies which did not apply for a trademark and have available economic information (merge = 1, called 'control group' group' / control = 1). The trademark group consists of 621.810 applications form 196.594 companies and the control group of 73.936 companies.

Based on the literature discussion above (see chapter 2.3 Trademarks in Innovation Research) the pharmaceutical and IT-Service industry reveal themselves as interesting industries to study. In his examination of Swedish companies Malmberg (2005) identifies the pharmaceutical industries as a strong user of patents as well as trademarks. Various studies examine KIS and KIBS and find positive correlation between innovation and trademarks (Gotsch and Hipp, 2012; Mendonça, Pereira, and Godinho, 2004; Schmoch and Gauch, 2009). According to the definition of Miles (2005) the IT-service industry, as a computer service, qualifies as a KIBS and furthermore, is a service industry

that registers a relatively high number of patents. Hence, the German pharmaceutical and IT-service industries are selected for further studies due to the evidence found in other papers.
Hence, the new database is filtered for the German pharmaceutical and IT-service companies and only registered trademarks are kept which leaves 7.235 observations.

	Industry	# Companies
Trademark Group	Pharmaceutical	292
	IT-services	1.375
	Overall	1.667
Control Group	Pharmaceutical	136
	IT-services	293
	Overall	429

Table 4: Distribution of companies among different groups and industries

The trademark group represents 1.667 companies with 6.816 registered trademarks and the control group 429 companies of the whole dataset. The source for the patent data is the European Patent Office (EPO). The advantages of using the EPO database are similar to the OHIM database. Firstly, EPO and OHIM cover roughly the same geographic area, including Germany. Secondly, based on the BVDID the database provides a good overview, which European patens companies hold. Thirdly, the EPO data is freely available in an electronic form. The overall database comprises 1.355.949 patent entries from various European companies. Each objective was merged with the priority information in order to determine the filing date and hence the expiry date. Based on this information a count of patents by company was created, giving the number of valid patents for each year between 2005 and 2014. As a next step the complete patent information was merged with the trademark and control group. After the merge, companies with and without patents were kept. Overall 620 companies from the dataset hold valid 22.842 patents (see appendix 1).
After the data preparation the dataset contains data of companies from the German pharmaceutical and IT-service sector regarding economic information like sales and employment, trademark information as well as patent infor-

mation. Based on the final database various statistical analyses are performed. The methodology will be outlined in the next chapter.

3.2 Methodology

The description of the methodology is separated into two parts. Firstly, the descriptive and afterwards the growth analysis will be described.

Descriptive Analysis

Regarding the descriptive analysis a few relevant steps have been taken. Firstly, in order to analysis sales and employment in a timely independent manner, only the latest available sales, respectively, employment data has been used. Furthermore, different division were created in order to reach a better understanding of the dataset. Firstly, a clustering of the companies using the number of registered trademarks was conducted. Based on these clusters various age, sales and employment analysis were conducted. Secondly, different age clusters were created to understand average number of trademarks based on the time a company existed. Thirdly, clusters based on sales were built in order to get an overview about the different sales groups. Fourthly, the same clustering was performed for employment. Fifthly, a classification regarding size was implemented. Moreover, differentiation along types of trademarks was made in order to identify different usage patterns. The classification in different groups (trademarks, age, size, sales, employment) follows the purpose to simplify descriptive analysis and make them easier to read and interpret.

For the multiple regression analysis three different dummy variables were created, which function as the independent variables: 1) IT dummy (takes value 1 if IT-service company) 2) small dummy (takes value 1 if size equal or small than 100 employees) 3) age dummy (takes value 1 if company younger than six years). As a dependent variable the number of trademarks in comparison to number of employees was chosen. With this variable it is possible to understand the influences of different factors on the number of trademarks and control for size effect through the employment information.

Growth Analysis

As a first step a count of number of trademarks was created for each company, overall as well as segmented by type for. Next the complete data was collapse by company and transformed into a time series in order to perform further analysis. The time series covers the years 2005 to 2014 for every company and indicates in which year a certain type of trademark was filled. The structure of the time series allows differentiating by years since a trademark was filled.

In order to fill gaps in growth data, a compounded annually growth rate (CAGR) as calculated. The CAGR allows evaluating growth statistics even if no data exists fro the respective year.

Subsequently, the actual growth analyses were conducted. For the trademark group, only growth rates were used that lay within a ten-year time frame after the filing of a registered trademark. This follows the results of Millot (2009) regarding the long-term effect of trademarks. The usage of the filing year, and not the registration year, is explained by the possibility to directly use a trademark and that trademarks are filled shortly before usage (Hipp and Grupp, 2005; Mendonça, Pereira and Godinho, 2004).

Generally, an overall analysis was performed as well as a separate analysis of the pharmaceutical and IT-service industries. In order to allow comparison with the control group two different outputs were used for the growth statistics. Firstly, an analysis was conducted which estimates the average growth relative to the year a trademark was filled (examination of year 1 to year 10 after the filing separately as well as growth averages of the years 1-5, 6-10 and 1-10). However, this analysis does not allow a direct comparison between the trademark group and the control group because the control companies did not file trademarks and thus do not have a filing year. Hence, a second analysis was performed comparing the trademark and the control group year by year (from 2006 to 2014).

After the initial general analysis between trademark and control group, growth averages were used for the comparison of different sub categories. Firstly, a differentiation took place between small and medium business (SMB) and big corporation. The objective is to understand the impact of innovation on small companies and if trademarks are more suitable as an indicator such firms (Krasnikov, Mishra, and Orozco, 2009; Mansfield, 1962). Companies with 100 or less employees were subsequently classified as SMBs.

Along the same objective a separation between young and old companies took place. For this purpose the companies were divided in three different groups: 1) younger or equal to 5 years, 2) between 6 and 10 years and 3) older than 10 years. The age analysis was adapted on a year-to-year basis where the companies became older within the time series.

In order to evaluate the impact of different type of trademarks, a comparison between growth statistics for word, figurative and other trademarks was conducted. Other trademarks are defined as 3D, colour and sound and group because of their limited appearance within the dataset.

The last part of the empirical studies covers with the relationship of trademarks, patents and growth statistics. As a first step a yearly patent and count for each company was created. Based on this count various correlation and growth analysis were performed.

After explaining the methodology of the various analyses the next section presents the outcome and empirical results of this study.

3.3 Results

The following results are split into two parts. Firstly, a descriptive analysis is presented regarding the dataset, the trademarks, companies divided by industry as well as sales and employment information. The second part outlines the performed growth analyses for the trademark and control group.

3.3.1 Descriptive analysis

The dataset consist of 2.291 companies.

Absolut frequency	Pharmaceuticals	IT-service		**Relative Frequency**	Pharmaceutical	IT Services	
Trademark Group	292	1.375	1.667	Trademark Group	14%	66%	1667
Control Group	136	293	429	Control Group	6%	14%	429
	428	1.668	2.096		20%	80%	2.096

Table 5: Absolute and relative number of companies within the trademark and control

Hereof 1.667 companies are within the trademark group and 429 companies are in the control group. Overall, 428 companies are from the pharmaceutical industry and 1.668 from the IT-service industry. Table 5 reveals that overall the dataset contains 4 times as many IT-service companies as pharmaceutical companies.

Intellectual Property Right Distribution

Table 6 outlines the number of trademarks and patents within each group, giving a split by industry and group. A notable fact is that the absolute number of trademark and patents is higher for the pharmaceutical industry than the IT-Service industry, which is caused by the higher number of IPRs for pharmaceutical companies.

Year 2014	Industry	# Registered Trademarks	Average # Trademarks	Companies w Trademarks	# Valid Patents	Average # Patents	Companies w Patents
Trademark Group	Pharmaceutical	3.829	13,1	292	17.714	121,3	146
	IT services	2.918	2,1	1.375	596	4,5	130
	Overall	6.747	4,0	1.667	18.310	66,3	276
Control Group	Pharmaceutical	-	-	-	4.065	32,2	126
	IT services	-	-	-	467	2,1	218
	Overall	-	-	-	4.532	13,1	344

Table 6: Trademark and patent distribution

Furthermore, a pharmaceutical company has on average 9,3 patents per trademark, while for the IT-service industry the same ration is much lower with 2,1 patents per trademark. These evidence show that both industries rely on the usage of trademarks as well as patents; however, the IT-service industry, as a KIBS, uses relatively more trademarks and thus confirms findings from previous studies (see chapter 2.3.2 Trademarks in the service industry).

The companies were clustered into groups based on the number of registered trademark.

Trademark Cluster	Overall		Pharmaceutical		IT-Service	
	#	%	#	%	#	%
1	939	56,33	94	32,19	845	61,45
2	331	19,86	45	15,41	286	20,8
3	108	6,48	21	7,19	87	6,33
4	70	4,2	20	6,85	50	3,64
5	41	2,46	13	4,45	28	2,04
6	23	1,38	9	3,08	14	1,02
7	29	1,74	12	4,11	17	1,24
8	18	1,08	10	3,42	8	0,58
9	15	0,9	6	2,05	9	0,65
10	13	0,78	9	3,08	4	0,29
]10-20]	48	2,88	31	10,62	17	1,24
]20-50]	18	1,08	9	3,08	9	0,65
]50-100]	6	0,36	5	1,71	1	0,07
>100	8	0,48	8	2,74	-	-
Total	1.667	100	292	100	1.375	100
Skewness	17,07		7,30		9,76	
Kurtosis	336,64		61,60		153,89	

Table 7: Trademark cluster overall and by industry

Firstly, it is noticeable that no IT-service company has more than 100 trademarks and that more than 61% only have a single one. Almost 90% of the companies have three or less trademarks. In the pharmaceutical industry over 80% of the companies have between one and ten trademarks. These findings are confirmed by the skewness and kurtosis of the two distributions. The distribution of trademarks in pharmaceuticals is more evenly than in IT-services and the tail of the IT-service is much heavier showing that the tail is relatively longer. This adds that the IT-service companies only use a more limited number of trademarks compared to pharmaceuticals and that companies with a high number are relatively rare.

Also the usage of different type of trademarks reveals interesting difference between the industries.

Year 2014	Overall		Pharmaceutical		IT-service	
Type	**#**	**%**	**#**	**%**	**#**	**%**
3-D	16	0,23%	16	0,41%	0	0,00%
Colour	1	0,01%	1	0,03%	0	0,00%
Figurative	1344	19,72%	555	14,35%	789	26,76%
Sound	3	0,04%	3	0,08%	0	0,00%
Word	5452	79,99%	3.293	85,13%	2159	73,24%
Overall	6.816	100%	3.868	100%	2.948	100%

Table 8: Types of trademarks

Looking at table 8 it becomes obvious that pharmaceutical not only use more trademarks, but also more advanced ones. While IT-service companies use only word and figurative trademarks, pharmaceutical ones rely on 3-D figures, colours and sounds, even though in very small numbers. This confirms the observation that pharmaceutical companies are heavier users of trademarks, not only in number but also in types. Interestingly, the usage of figurative trademarks is relatively higher in IT-service with 27% compared to 14%. Holograms, olfactory (scents) and any other form of trademarks are not used by any of the two industries. After studying the different types of trademarks on an individual basis, the next step is to analyse the composition within the companies and how they tend to combine.

Trademark Type Combinations	#	%	Trademark Type Combinations	#	%	Trademark Type Combinations	#	%
fig	307	18,42	fig	41	14,04	fig	266	19,35
word	987	59,21	word	138	47,26	word	849	61,75
word_fig	366	21,96	word_fig	106	36,3	word_fig	260	18,91
word_fig_other	6	0,36	word_fig_other	6	2,05	word_fig_other	0	0
word_other	1	0,06	word_other	1	0,34	word_other	0	0
Total	1.667	100	Total	292	100	Total	1.375	100

Table 9: Combination of different trademark types

Examining table 9 is clearly demonstrates that the single usage of word trademarks is by far the most frequent combination. Especially in the IT-service industry over 60% of the companies solely use word trademarks. Regarding the second most used combination differences in the industries are noticeable. While in the pharmaceutical industry the word & figurative combination is used by 36% of the companies, companies in the IT-service industry evenly use solely figurative or a combination of word and figurative trademarks. 3-D, colour and sound trademarks appear only in combination with word or word and figurative trademarks and only in the pharmaceutical industry.

The next part covers the distribution of patents overall and within the industries (table 10). Similar to the pattern of trademarks, the pharmaceutical industry is a heavier user of patents.

npat_cluster	Overall		Pharmaceutical		IT-Service	
	#	%	#	%	#	%
1	233	38%	51	20%	182	50%
2	121	19%	42	16%	79	22%
3	49	8%	20	8%	29	8%
4	43	7%	21	8%	22	6%
5	24	4%	11	4%	13	4%
6	16	3%	11	4%	5	1%
7	10	2%	6	2%	4	1%
8	10	2%	5	2%	5	1%
9	6	1%	3	1%	3	1%
10	4	1%	2	1%	2	1%
]10;20]	41	7%	28	11%	13	4%
]20;50]	28	5%	23	9%	5	1%
]50;100]	10	2%	9	3%	1	0%
]100;[	26	4%	26	10%	-	-
Total	2.260	100	258	100	363	100
Average # of Patents	35,78		79,05		3,01	

Table 10: Patent distribution

While over 50% of the IT-services have only one patent, the same is only the case for 20% of the pharmaceutical companies. Moreover, 44% have more than 5 patents and 10% even more than 100. None IT-service company has that many patents. This difference in distribution is also reflected in the average number of trademarks with 79 respectively 3 patents per company (if trademark and control group are combined).

The correlation between the count patents and the count of trademarks reveals a moderately high value of 0,5202. This is in line with the previous findings of the dataset that the trademark group is a heavier user of patents than the control group.

Overall (1684)		
	Patent	Trademark
Patent	1	
Trademark	0,5202	1

Pharmaceutical			IT-Services		
	Patent	Trademark		Patent	Trademark
Patent	1		Patent	1	
Trademark	0,5163	1	Trademark	0,1814	1

Table 11: Correlation between patents and trademarks

The IT-service industry, however, has a low coefficient of only 0,1814. Hence, the linear relation is positive, but very weak. To get a better understanding, the companies were analysed in absolute and relative terms regarding their IPR holdings.

Year 2014	Group	Overall		Pharmaceutical		IT-Services	
		Patent	No Patent	Patent	No Patent	Patent	No Patent
Absolute	Trademark	271	1396	141	151	130	1245
	No Trademark	318	111	108	28	210	83
Relative	Trademark	13%	67%	33%	35%	8%	75%
	No Trademark	15%	5%	25%	7%	13%	5%

Table 12: IPR holdings of companies by industry

Table 12 show that one third of the pharmaceutical companies combine patents and trademark, while 60% rely on only one of the two. IN the IT-service industry, however, over 88% of the companies use only one form of IPR (13% patents, 75% trademarks) and only 8% combine the two forms. Interestingly, the share of companies within the pharmaceutical industry is higher than in the IT-service industry with 7% and 5%, respectively. The regression analysis confirms this picture. The influence of patents on trademarks in the pharmaceutical industry is much higher, which is indicated by the patent coefficient of 4,44 compared to 0,16 in the IT-services.

Overall			
ntrade	Coef	Std. Error	P>|t|
count_pat	4,4069270	.1580888	0,000
Const	-3,4330230	2.931.887	0,242

Number obs	2.096
R-squared	0,2707

Pharmaceutical				IT-service			
ntrade	Coef	Std. Error	P>|t|	ntrade	Coef	Std. Error	P>|t|
count_pat	4,4485810	.3575017	0,000	count_pat	.1558918	.0207099	0,000
Const	10,6819800	1.444.338	0,460	Const	.3617692	.0757579	0,000

Number obs	428	Number obs	1.668
R-squared	0,2666	R-squared	0,0329

Table 13: Linear regression of number of patent count on number of trademarks

Furthermore, the r-squared it higher for the pharmaceutical industry, showing that 23% (0,26 – 0,03) more of the variation is explained by patents in this industry. In general the findings of Malmberg (2005) study of the Swedish pharmaceutical industry are confirmed and we find a correlation between the number of patents and trademarks, indicating that innovative firms in this industry rely on trademarks (see also appendix 2 – 4). The findings regarding the IT-service industry are inconclusive, since the number of patents is relatively low and hence the mutual usage of patents and trademarks is not widely adopted. This confirms previous studies of the KIBS and shows that a new indicators are need (Gotsch and Hipp, 2012; Hipp and Grupp, 2005; Schmoch and Gauch, 2009).

Age Distribution

The next analysis examines the age of companies and its distribution in the dataset. Firstly, a classification into three different age groups was performed: 1) age group 0 – 5 2) age group 6 – 10 3) age group older than 10. Based on this classification the distribution along the age was conducted (see table 14).

Group	Absolute	[0 ; 5]	[6 ; 10]	[11 ; [		Relative	[0 ; 5]	[6 ; 10]	[11 ; [	
Trade mark Group	Pharma	32	31	229	292	Pharma	1,92%	1,86%	13,74%	17,52%
	IT-Service	553	587	235	1.375	IT-Service	33,17%	35,21%	14,10%	82,48%
		782	619	266	1.667		46,91%	37,13%	15,96%	100,00 %
Con-trol Group	Pharma	17	17	102	136	Pharma	3,96%	3,96%	23,78%	31,70%
	IT-Service	103	55	135	293	IT-Service	24,01%	12,82%	31,47%	68,30%
	Total	120	72	237	429	Total	27,97%	16,78%	55,24%	100,00 %

Table 14: Age distribution by industry and group

The distribution of young companies in the IT-service industry attracts attention. Whereas 20% of the pharmaceutical companies in the control group are between the age of 0 and 10, in the IT-services over 80% are within this age group. In contrast young IT-service companies in the control group represent only 53% and young pharmaceutical companies 25%.

Next the distribution of trademarks within different age clusters was examined. Firstly, one notices that the number of trademarks rises with the age of companies and that the pharmaceutical companies are on average more than 30 years older than the IT-service companies

Year 2014	Pharmaceutical			IT Services		
Age Cluster	Trademarks	Std. Error	Observations	Trademarks	Std. Error	Observations
0	-	-	-	1,3	0,097353	50
1	2,7	1,085766	10	1,3	0,0683595	156
2	2,3	0,521641	7	1,5	0,1197788	162
3	5,6	3,316288	8	1,6	0,1299780	97
4	3,2	1,019804	5	3,1	1,1471090	63
5	2,0	1,000000	2	1,7	0,1733917	59
6-10	2,7	0,452917	31	2,2	0,2253122	235
10-15	4,8	1,024892	32	2,6	0,2157126	273
15-25	12,2	7,962178	58	2,8	0,2605792	200
25-50	9,9	2,715817	53	2,7	0,4182443	63
50-100	16,1	6,296452	58	2,5	0,5000000	2
>100	47,7	1,845067	27	-	-	-
Mean Age	39,38			9,25		
Skewness	2,13			-0,15		
Kurtosis	7,07			1,47		

Table 15: Trademark distribution by age and industry

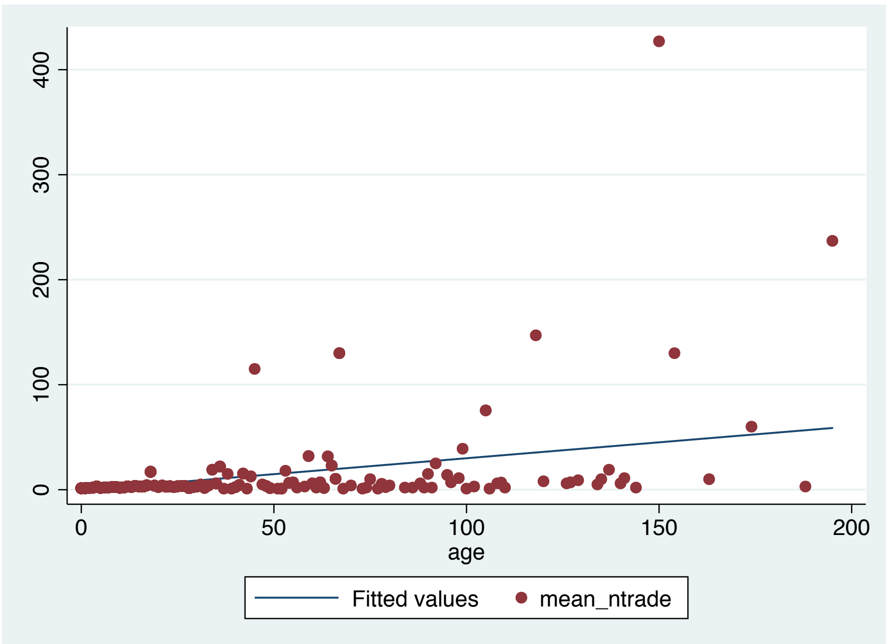
Moreover, the age has a much lower impact on the number of trademarks of an IT-service company compared to pharmaceutical companies. While the number of trademarks rises only by 1,2 between the age cluster 1 and 50-100 for IT-service companies, in the pharmaceutical industry the number trademarks rises by 45. This is also reflected in the skewness and kurtosis of industries. The skewness of IT-services is almost zero indicating an even distribution in contrast to 2,13 of pharmaceuticals. Furthermore, the kurtosis is bigger for pharmaceutical companies, showing that the distribution has more peaked than the other industry.

A linear regression analysis extends the insights about the relationship between age and number of trademarks. For the regression the age was used as the dependent variable and number of registered trademarks (more precisely the average number of trademarks by age) as the independent variable. The scatterplot combines age with the number of trademarks. The following tables and graphics outline the results of the regression analysis for the overall dataset as well as the two industries.

Mean_ntrade	Coef	Std. Error	P>|t|
Age	0,3031460	0,0154798	0,000
Const	-0,3415158	0,3991046	0,392

Number obs	1.651
R-squared	0,1887

Table 16: Linear regression of average number trademarks by age for the overall dataset



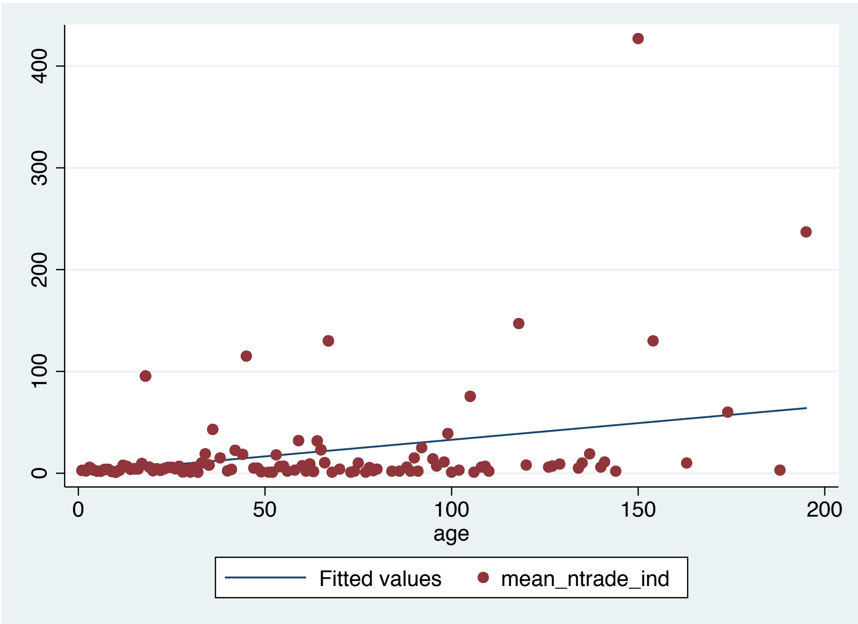
Graphic 1: Scatter plot comparing age and number of trademarks

In the overall dataset each year a company ages increases the number of trademarks on average by 0,327. While the R-squared is relatively low with a value of 0,125, the age coefficient is significant at a 1% level.

Mean_ntrade	Coef	Std. Error	P>|t|
Age	0,3271566	0,0509051	0,000
Const	0,1630847	2,8130320	0,954

Number obs	291
R-squared	0,1250

Table 17: linear regression of number trademarks by age for pharmaceutical industry



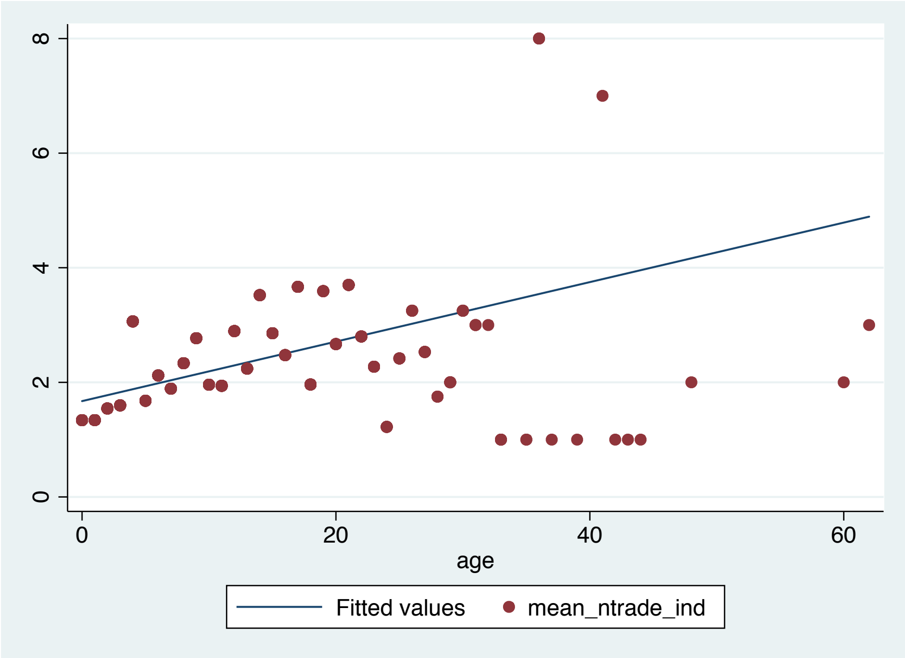
Graphic 2: Scatterplot comparing age and number of trademarks for the pharmaceutical industry

The pharmaceutical industry has a slightly higher age coefficient, which again is significant at 1% level. The R-squared is even lower than the one for the overall dataset and furthermore, the scatter graph show that the outliers are mostly companies from the pharmaceutical industry.

Mean_ntrade	Coef	Std. Error	P>|t|
Age	0,0519178	0,0020743	0,000
Const	1,6725870	0,0257042	0,000

Number obs	1.360
R-squared	0,3157

Table 18: linear regression of average number trademarks by age for IT-service industry



Graphic 3: Scatterplot comparing age and number of trademarks for the IT-service industry

The IT-service companies have a much lower age coefficient, which increase the number of trademarks only by 0,05 for each year, but is still significant at a 1% level. Yet, the R-squared is the highest among the three linear regressions and indicates a positive linear correlation between age and number of trademarks.

Sales Distribution

Next a closer look at the distribution of sales will be taken. Firstly, the companies were divided into different sales cluster to gain a first overview. Almost 86% of the IT service companies make less than € 10 million, while more than 50% of the pharmaceutical companies make more than € 10 million. This is also reflected in the average sales with € 530 million and € 12 million, respectively (see Appendix 6). Table 19 gives an overview of the sales distribution related to trademarks and highlight differences between the industries.

Sales [in 000 €]	Pharmaceuticals			IT-services		
# Trademarks	Sales	Std. Error	Observations	Sales	Std. Error	Observations
1	44.706	18.229	61	9.155	4.615	436
2	89.449	57.408	32	5.075	802	170
3	125.005	90.320	16	7.929	1.671	62
4	34.962	26.612	13	4.578	1.094	39
5	25.340	8.455	11	7.190	1.984	18
6	48.891	12.621	9	24.741	12.218	12
7	44.162	17.722	11	21.775	10.658	11
8	237.768	174.345	10	474.995	452.942	5
9	82.326	53.330	5	28.686	18.201	5
10	400.470	143.323	8	22.939	11.198	3
10-20	619.541	319.952	27	24.668	7.601	16
20-50	155.979	42.847	7	33.651	8.967	8
50-100	2.033.058	1.605.881	3	-	-	1
>100	9.758.783	5.007.908	8	-	-	-
Average Sales per Trademark	33.650			6.492		

Table 19: Sales distribution by number of trademarks and industry

Besides two outliers in each industry in the ‘8 trademarks’ group, pharmaceutical companies generate more sales in each trademark group. This difference becomes clearer especially from ten trademarks onwards, when the gap increases extremely. The disparity is also reflected when examining the linear relations between the number of trademarks and average sales. Overall, a positive relation is found where each added trademark generates on average € 40,6 million in sales, which is significant at a 1% level. The R-squared is high with a value of almost 0,5 and by the scatterplot some outliers are revealed which have more than 200 trademarks. Similar results are found for the pharmaceutical industry, which dominates the overall analysis due to its large values (table 20). The sales impact of each added trademark is even higher compared and the R-squared is almost the same. The coefficient is significant at a 1% level. Looking at the IT-services one notices that the number of trademark influences the sales in a much smaller way.

Normal			
sales	Coef	Std. Error	P>|t|
ntrade	40.587,55	1.318,86	0,000
Const	-92.821,16	34813,76	0,000

Number obs	1.007
R-squared	0,4852

Normal				Normal			
sales	Coef	Std. Error	P>|t|	sales	Coef	Std. Error	P>|t|
ntrade	41.512,75	2.882	0,000	ntrade	1.499,28	913	0,101
Const	-116.280,00	160.161,2	0,469	Const	8.238,36	4.515,3	0,068

Number obs	221	Number obs	786
R-squared	0,4865	R-squared	0,0034

Table 20: Linear regression of average sales by number trademarks for the overall

Each added trademark only adds € 1,5 million in sales to the company and furthermore, the coefficient is not significant. This disparity is also visible in the average sale per trademark. With € 33,65 million the indicator of pharmaceuticals it is more than five times higher than the IT-services one. Comparing the sales per trademark in each group, it seems that this figures is declining with the number of trademark. Ignoring ‘8 trademark’ group with two outliers, the highest figures are in the ‘1 trademark’ and ‘2 trademark’ group. Based on these findings it seems that there is a natural limit for sales, respectively, productivity per trademark in an industry. One explanation for the lower figure of IT-services could be the relation of services to human input, which negatively influences scalability.

Sales per trademark	Pharmaceutical			IT Services		
# trademarks	Sales	Std. Error	Observations	Sales	Std. Error	Observations
1	44.706	18.229	61	9.155	4.615	436
2	44.725	28.704	32	2.538	4.008	170
3	41.668	30.107	16	2.643	5.568	62
4	8.741	6.653	13	1.144	2.734	39
5	5.068	1.691	11	1.438	3.968	18
6	8.148	2.104	9	4.124	2.036	12
7	6.309	2.532	11	3.111	1.523	11
8	29.721	21.793	10	59.374	56.618	5
9	9.147	5.926	5	3.187	2.022	5
10	40.047	14.332	8	2.294	1.120	3
10-20	44.350	24.685	27	1.880	6.049	16
20-50	4.962	1.086	7	1.420	4.393	8
50-100	33.615	26.910	3	53	-	1
>100	37.908	15.191	8	-	-	-
Average Sales per Trademark	33.650		221	6.492		786

Table 21: Average sales per Trademark by industry

The regression of average sales per trademark and number of trademarks confirms the finding of table 21 and reveals that there is no linear relationship between the two variables and that the sales per trademark are independent of the number of trademarks (table 20 – 21).

Normal			
sales_ntrade	Coef	Std. Error	P>|t|
ntrade	87,94	102,28	0,390
Const	11.978,24	2.700	0,000

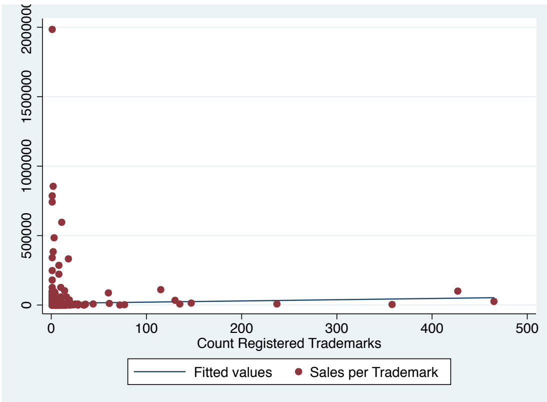
Number obs	1.007
R-squared	0,0007

Normal				Normal			
sales_ntrade	Coef	Std. Error	P>|t|	sales_ntrade	Coef	Std. Error	P>|t|
ntrade	2,18	143	0,988	ntrade	-240,18	609	0,693
Const	33.616,17	7.945,5	0,000	Const	7.096,93	3.010,1	0,019

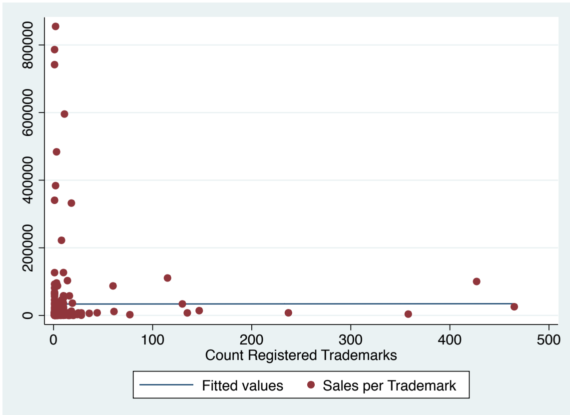
Number obs	221
R-squared	0,0000

Number obs	786
R-squared	0,0002

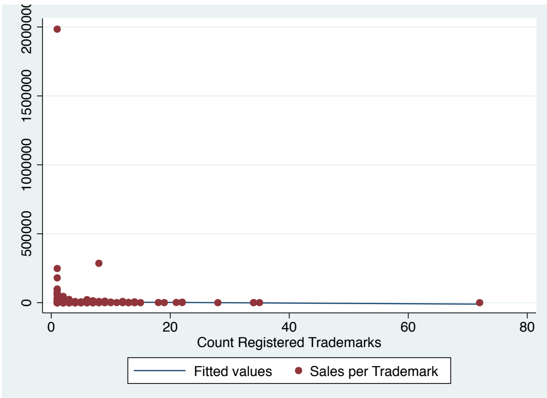
Table 22: Linear regression of sales per trademark by trademark group for the overall dataset and by industry



Graphic 4: Scatter graph comparing # trademarks and average sales per trademark



Graphic 5: Scatter graph comparing # of trademarks and average sales per trade-mark for the pharmaceutical industry



Graphic 6: Scatter graph comparing # of trademarks and average sales per trade-mark for the IT-service industry

The scatterplots, however, reveal an interesting insight. The variance of sales per trademark is the highest when the number of trademarks is low. Within the pharmaceutical industry this phenomena is especially strong compared to the IT-service industry, except for on outlier. This is consistent with the findings of table 21.

Employment Distribution

After analysing sales information the following part deals with employment information. Firstly, the companies are divided by number of employees (see Appendix 7). As inferred from the previous data, the pharmaceutical companies have on average more employees. While 37% (108 companies) have more than 100 employees, the same is only true for 12% (169 companies) of the IT-service industry. On average a pharmaceutical company employs 1.131 people and an IT service one only 40, a difference of more than 1.000 employees per company.

Emp	Pharmaceutical			IT-Services		
# trademarks	Emp	Std. Error	Observations	Emp	Std. Error	Observations
1	74	17,1	89	26	3,4	794
2	215	117,4	45	32	4,1	272
3	274	166,2	21	41	6,4	84
4	32	9,1	20	41	6,4	50
5	125	45,8	13	44	10,9	28
6	209	52,0	9	122	51,5	14
7	177	82,8	12	40	9,8	16
8	774	564,6	10	845	768,3	8
9	201	76,1	6	222	126,9	9
10	958	346,8	9	114	25,4	4
10-20	933	373,6	31	146	45,8	17
20-50	456	165,4	9	201	64,0	9
50-100	12.741	12.383,0	4	12	-	1
>100	24.222	14.232,5	8	-	-	-
Average Emp per Trademark	69,9			21,9		

Table 23: Employment by # of trademarks

This is also reflected in the average employment per trademark in the industries. While IT-services are comparably low with 21,9 the pharmaceutical companies employ more than three times as many people per trademark, namely 69,9. The employment information overall are in line with the sales information, were the pharmaceutical industry was strictly bigger than the IT-service industry.

Overall			
emp	Coef	Std. Error	P>|t|
ntrade	113,38	3,00960	0,000
Const	-237,42	63,81140	0,000

Number obs	1.592
R-squared	0,4716

Pharmaceutical				IT-Service			
emp	Coef	Std. Error	P>|t|	emp	Coef	Std. Error	P>|t|
ntrade	116,66	7,2739	0,000	ntrade	7,41	1,55003	0,000
Const	-415,32	358,1973	0,247	Const	23,52	6,38157	0,000

Number obs	286	Number obs	1.306
R-squared	0,4753	R-squared	0,0172

Table 24: Linear regression of employment by trademark group for the overall dataset and by industry

The results from conducting a linear regression for employment using number of trademarks as a independent variable shows that the number of employees rises with the number of trademarks. While all coefficients are significant at a 1% level, the impact in pharmaceuticals with 116,6 is much higher than in IT-service with 7,4. The quality of the regression is high overall and for pharmaceuticals with 0,4716, respectively, 04753 and low for IT-Services with an R-squared of 0,0172.

Size Distribution

The next descriptive part is a short description of the dataset regarding size of the company. Small companies are defined by their number of employees, whereas 100 employees or less is defined as small.

Group	Absolute	Big	Small		Relative	Big	Small	
Trademark Group	Pharma	108	184	292	Pharma	6,48%	11,04%	17,52%
	IT-Service	169	1.206	1.375	IT-Service	10,14%	72,35%	82,48%
		277	1390	1.667		16,62%	83,38%	100,00%
Control Group	Pharma	51	85	136	Pharma	11,89%	19,81%	31,70%
	IT-Service	25	268	293	IT-Service	5,83%	62,47%	68,30%
		76	353	429		17,72%	82,28%	100,00%

Table 25: Distribution of companies by size

Distinguishing between trademark and control group a few things are noticeable. Firstly, within the pharmaceutical industry small and big companies are more evenly distributed compared to the IT-service sector. This applies to the trademark group as well as the control group. Secondly, within the control group, the share of big IT-service companies is even smaller then in the trademark group. Overall, big companies account for 17% roughly of the whole dataset.

Linear regression model for number of trademarks

As the last part of the descriptive analysis a multiple linear regression model was build. The purpose of the model is to understand different factor that influence the number of trademarks a companies maintains. In order to account for size effects, the number of trademarks in relation to number of employees was used as the dependent variable.

ntrade_emp	Coef.	Std. Err.	t	P>t
it_dummy	-0,3305668	0,0909627	-3,63	0,000
small_dummy	0,4929355	0,1050596	4,69	0,000
age5_dummy	0,4347202	0,0711201	6,11	0,000
_cons	0,172988	0,1015743	1,70	0,089

Number of obs	1.592
R-squared	0,044

Table 26: multiple linear regression model for numbers of trademarks

The different independent variable explain certain relationships: 1) being an IT-service company reduces the number of trademarks on average by 0,33, 2) small companies hold on average 0,49 trademarks more than big ones and 3) companies existing for only five years or less have normally 0,43 trademarks more than companies older than five years. All the presented factors are significant at a 1% level.

After the comprehensive description analysis of the dataset the following chapter explains the results from the growth analysis and gives an

3.3.2 Growth Analysis

The aim of the growth analysis is to examine the influence of trademarks on innovation, whereas innovation is proxied by sales and growth statistics. Firstly and overview of the average growth rate in both industries is given in order to be able to correctly evaluate the achieved results and understand differences between the sectors

Type	Pharmaceutical			IT-Services		
	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
Sales	1,270436	0,1040437	1.355	1,338445	0,0791139	3.323
Emp	1,110557	0,0240025	1.966	1,315025	0,028753	6.041

Table 27: Growth overview by industry

IT-service companies experience stronger growth for sales and employment; however, the difference for employment compared to the pharmaceutical industries is higher. The results of the growth analysis are discussed in the following chapter.

Growth Analysis by Trademark Usage

Sales Growth

The first conducted analysis examines the growth rates in relation to the filing year of a trademark. Overall, companies achieve and average sales growth rate of 25,3% per year if within the 10 years after the filings.

Trademark Group			
Sales Growth	**Overall**		
Year	Mean	Std Error	Observations
0	1,393630	0,103806	625
1	1,241635	0,051017	451
2	1,723295	0,5946702	376
3	1,131758	0,0300594	285
4	1,102606	0,0433874	223
5	1,186093	0,0518987	201
6	1,083122	0,0287965	152
7	1,153168	0,0488037	131
8	1,023696	0,0218073	112
9	1,106979	0,0556911	85
10	1,107802	0,0431564	79
1-5	1,311701	0,1467173	1536
6-10	1,094746	0,0179219	559
1-10	1,253812	0,1076865	2.095

Table 28: sales growth according to years after filing of trademark for the overall dataset

Especially year 2 stands out with an average growth rate of 72,3% after filing a trademark. When the impact is evaluate only between years 1 to 5 the growth rates become even bigger. Examining the two industries some differences are noticeable (see table 29)

Trademark Group						
Sales Growth	Pharmaceutical			IT-Services		
Year	Mean	Std Dev	Observations	Mean	Std Dev	Observations
0	1,1396250	0,0499543	259	1,5733780	0,1731951	366
1	1,077463	0,0306557	130	1,308123	0,0702919	321
2	1,079892	0,0298689	115	2,006787	0,85650	261
3	1,142178	0,0608565	91	1,126870	0,0338052	194
4	1,048554	0,0346507	65	1,124843	0,0595376	168
5	1,235790	0,1314878	57	1,166421	0,0506824	144
6	1,016611	0,0698143	39	1,106077	0,030245	113
7	1,184507	0,1664348	29	1,144258	0,0418379	102
8	0,931794	0,0615019	26	1,051480	0,0208162	86
9	1,323529	0,2682857	17	1,052841	0,0185658	68
10	1,267468	0,1692169	19	1,057241	0,0171885	60
1-5	1,106533	0,0238889	458	1,398869	0,2087779	1.078
6-10	1,113900	0,0618328	130	1,088942	0,014004	429
1-10	1,108162	0,0230618	588	1,310642	0,1494216	1.507

Table 29: Sales growth according to years after filing of trademark for the pharmaceutical and IT-service industries

Firstly, when filing a trademark, the impact is much higher for IT-service companies compared to with an average growth rate of 31%. In contrast, pharmaceutical companies average only at 10,8%. Companies in the IT-service industry experience the highest growth rate in the years 1 to 5 after filing a trademark while the contrary is true for pharmaceutical companies, which have the highest rate from year 6 to 10. However, the difference is smaller and the growth rates more evenly distributed. Furthermore, this high overall growth rate in year 2 is explained by the high growth rate of the IT-service in the same year. In order to be able to evaluate these figures, a comparison with the control group is needed. Since a classification according to year after filing for a trademark is not possible for the control group, an analysis by year form 2006 to 2014 was conducted. Hereby, only growth rates for the control group were used if a trademark was filed within 10 years (see chapter 3.2 Methodology). The results are presented in table 30.

Trademark Group			
Sales Growth	Overall		
year	Sales Growth	Std Error	Observations
2006	1,219661	0,0717806	94
2007	1,116229	0,0276543	136
2008	1,152572	0,0305574	203
2009	1,095034	0,0287948	319
2010	1,098111	0,0195404	321
2011	1,783332	0,6454814	347
2012	1,190721	0,0428009	366
2013	1,162398	0,0536441	266
2014	1,411198	0,1796389	43
1-5 / 2005-2014	1,311701	0,1467173	1536
6-10 / 2005-2014	1,094746	0,0179219	559
1-10 / 2005-2014	1,253812	0,107687	2.095

Table 30: Trademark group sales growth according to year for the overall dataset

Trademark Group						
Sales Growth	Pharmaceutical			IT-Services		
year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
2006	1,111670	0,379551	37	1,289761	0,1152695	57
2007	1,064368	0,0380700	49	1,145438	0,0373296	87
2008	1,201475	0,0763920	61	1,131565	0,0288997	142
2009	1,130700	0,0695484	89	1,081233	0,0295749	230
2010	1,015194	0,0292413	83	1,127027	0,0240525	238
2011	1,062094	0,0252702	100	2,075331	0,9066205	247
2012	1,186678	0,0932206	96	1,192158	0,0477312	270
2013	1,125860	0,0810686	61	1,173271	0,0653667	205
2014	0,943500	0,0876482	12	1,592243	0,2401272	31
1-5 / 2005-2014	1,106533	0,0238889	458	1,398869	0,2087779	1.078
6-10 / 2005-2014	1,113900	0,0618328	130	1,088942	0,014004	429
1-10 / 2005-2014	1,108162	0,023062	588	1,310642	0,149422	1.507

Table 31: Trademark group sales growth according to year for the pharmaceutical and IT-service industries

Overall, the growth rates are the smallest in the years 2009 and 2010, which seam logical due to the financial crises. The year experiencing the highest growth is 2011; however, this is most likely caused by an outlier from the IT-service industry. Considering the industries separately, especially the negative growth rate for pharmaceuticals in year 2014 and the two high ones for IT services in 2011 and 2014 catch attention. Based on the years we can finally compare the trademark group with the control group.

Control Group			
Sales Growth	Overall		
year	Sales Growth	Std Error	Observations
2006	1,055539	0,0482546	49
2007	1,990039	0,6138458	68
2008	1,139468	0,0550553	100
2009	1,067678	0,0346761	135
2010	1,325399	0,2210012	141
2011	1,142397	0,0417490	141
2012	1,099518	0,0358335	126
2013	1,268853	0,1347996	73
2014	1,099682	0,1970473	6
2005-2014	1,228665	0,064657	839

Table 32: Control group sales growth according to year for the overall dataset

Control Group						
Sales Growth	Pharmaceutical			IT-Services		
year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
2006	1,052775	0,0763858	25	1,058419	0,0598214	24
2007	1,011044	0,0285870	23	2,490414	0,9219563	45
2008	1,032761	0,0479414	32	1,189684	0,0772553	68
2009	1,025725	0,0296840	43	1,087286	0,0489372	92
2010	1,690233	0,6453582	48	1,137098	0,041661	93
2011	1,087847	0,0413764	47	1,169672	0,0590624	94
2012	1,056235	0,0209563	42	1,121160	0,0526811	84
2013	1,058807	0,0292968	30	1,415396	0,2263299	43
2014	0,744007	0,5131362	2	1,277519	0,1468268	4
2005-2014	1,152746	0,106845	292	1,269193	0,081147	547

Table 33: Control group sales growth according to year for the pharmaceutical and IT-service industries

While there are some years in which the control group has higher sales growth rates than the trademark group, the aggregated growth rates of the trademark group are higher. Looking at the 1-5 year average, the difference becomes even greater.

Comparing the two industries, a very interesting finding can be observed. While IT-service companies within the trademark group achieve higher growth compared to the control group, the same is not true for pharmaceutical companies. Table 34 demonstrates these differences.

Group	Overall							
	Difference	Std Error	Observations	Pr(T > t)				
1-5	0,0830359	0,2042032	2373	0,3422				
1-10	0,025147	0,1750306	2.932	0,4429				
Group	Pharmaceutical				IT-Services			
	Difference	Std Error	Observations	Pr(T > t)	Difference	Std Error	Observations	Pr(T > t)
1-5	-0,0462137	0,0903785	748	0,6954	0,1296768	0,2987755	1623	0,3322
1-10	-0,044584	0,082062	878	0,7065	0,041449	0,2528205	2.052	0,4349

Table 34: Differences in sales growth rates

While no figure is significant the growth difference in IT-services is high with 12,9%, respectively, 4%. Both industries combined achieve a difference of between trademark group and control group growth of 8%, respectively, 2,5% and for the pharmaceutical industry the difference is in both case around -4,5%.

The results for sales growth confirm the theoretical findings discussed in chapter 2. Trademarks seem to better predict growth rates and innovation in the IT-service companies, while a causality between trademarks and sales growth cannot be proved in the pharmaceutical industry.

Employment Growth

Next, a closer look at the results of the growth analysis for employment is taken. The conducted analyses for this purpose are the same as for the growth analysis. A first look for the combined rates reveals a particularly strong growth in the first 5 years. Looking at the average of the 10 years within the time of filing a trademark, it is noticeable that the employment growth rate is even higher than the one of sales, while the standard error is lower in comparison. This shows that the growth rates of employment are less volatile.

Trademark Group			
Emp Growth	Overall		
Year	Mean	Std Error	Observations
1	1,337046	0,0624043	858
2	1,489757	0,1507869	691
3	1,294912	0,1151545	533
4	1,191767	0,0586888	407
5	1,343643	0,1365794	326
6	1,083318	0,0486636	246
7	1,174747	0,0983028	201
8	1,267095	0,1127036	167
9	1,182407	0,0969914	141
10	1,043903	0,0218228	126
1-5	1,346314	0,0502916	2815
6-10	1,149235	0,0373512	881
1-10	1,299337	0,0393467	3.696

Table 35: employment growth according to years after filing of trademark for the overall dataset

Examining the two industries separately (see table 36), the growth rates of IT-service companies are again higher with 35,9% compared to 9,7%.

Trademark Group						
Emp Growth	Pharmaceutical			IT-Services		
Year	Mean	Std Error	Observations	Mean	Std Error	Observations
1	1,053924	0,0174643	192	1,418667	0,0799717	666
2	1,047701	0,0183754	162	1,625131	0,1965511	529
3	1,038751	0,0216382	132	1,379235	0,1527084	401
4	1,024368	0,0281495	97	1,244147	0,0763376	310
5	1,398438	0,3738643	83	1,324927	0,1320071	243
6	1,233539	0,2137991	54	1,041068	0,0167955	192
7	1,119884	0,0887481	39	1,187954	0,1201710	162
8	1,139839	0,2036409	37	1,303314	0,1328824	130
9	1,041495	0,0297833	28	1,217323	0,1206861	113
10	1,033249	0,0777730	29	1,047088	0,0166611	97
1-5	1,088033	0,0474215	666	1,426358	0,0641246	2.149
6-10	1,131480	0,0766574	187	1,154020	0,0427058	694
1-10	1,097558	0,0406454	853	1,359878	0,0496243	2.843

Table 36: employment growth according to years after filing of trademark for the pharmaceutical and IT-service industries

Especially, the first five years experience particularly high growth, which is 27% higher than for the last five years. For the pharmaceutical companies the growth rates are more evenly distributed; however, similar to the sales rates the last five years experience stronger growth than the first five years. For comparison reasons, next a division along the years 2006 to 2014 was made.

Trademark Group			
Emp Growth	Overall		
year	Sales Growth	Std Error	Observations
2006	2,104638	1,046569	85
2007	1,074999	0,033916	198
2008	1,253820	0,084411	357
2009	1,171170	0,043377	527
2010	1,219935	0,056964	588
2011	1,423596	0,107757	640
2012	1,293028	0,099315	653
2013	1,307491	0,071061	509
2014	1,492814	0,141359	139
1-5 / 2006 – 2014	1,346314	0,0502916	2815
6-10 / 2006 – 2014	1,149235	0,0373512	881
1-10 / 2006 – 2014	1,299337	0,0393467	3.696

Table 37: Trademark group employment growth according to year for the overall dataset

Trademark Group						
Emp Growth	Pharmaceutical			IT-Services		
year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
2006	1,062046	0,0321473	34	2,799699	1,744204	51
2007	1,012223	0,0226801	57	1,100377	0,046624	141
2008	1,036531	0,0294909	98	1,336037	0,115467	259
2009	1,015145	0,0207095	126	1,220196	0,056431	401
2010	1,033220	0,0318149	133	1,274513	0,072848	455
2011	1,263860	0,2054091	152	1,473350	0,126036	488
2012	1,147801	0,0862667	133	1,330172	0,122732	520
2013	1,102917	0,081457	94	1,353829	0,085053	415
2014	1,040978	0,0415217	26	1,596776	0,172283	113
1-5 / 2006 – 2014	1,088033	0,0474215	666	1,426358	0,0641246	2.149
6-10 / 2006 – 2014	1,131480	0,0766574	187	1,154020	0,0427058	694
1-10 / 2006 – 2014	1,097558	0,0406454	853	1,359878	0,0496243	2.843

Table 38: Trademark group employment growth according to year for the pharmaceutical and IT-service industries

Table 37 and 38 demonstrate the growth per year overall and by industry. In the pharmaceutical industry, the impact of the financial crises is noticeable with the low growth rates. For the IT-Service companies especially year 2006 is outstanding with a growth rate of 179,9%; however, the standard error is very high with 1,74 indicating and outlier, who is responsible for the extreme rate. Using the yearly growth rates, a comparison with the control group can be made.

Control Group			
Emp Growth	Overall		
year	Sales Growth	Std Error	Observations
2006	1,143389	0,086618	49
2007	1,165153	0,069893	110
2008	1,064060	0,018951	164
2009	1,057670	0,028974	222
2010	1,215221	0,076575	243
2011	1,170870	0,982436	237
2012	1,966540	0,038690	202
2013	1,198347	0,539734	122
2014	1,030023	0,181878	29
2005-2014	1,215198	0,0537377	1.378

Table 39: Control group employment growth according to year for the overall dataset

Control Group						
Emp Growth	Pharmaceutical			IT-Services		
year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
2006	1,030023	0,064949	29	1,307771	0,187138	20
2007	1,031378	0,026517	43	1,251009	0,112573	67
2008	1,023360	0,013913	50	1,081911	0,026442	114
2009	1,002104	0,024528	71	1,083797	0,040892	151
2010	1,046639	0,024830	75	1,290480	0,109812	168
2011	1,072379	0,045733	73	1,214710	0,140518	164
2012	1,102482	0,047036	59	1,178535	0,051072	143
2013	1,035329	0,043302	37	2,371890	0,771682	85
2014	1,008342	0,008342	9	1,283850	0,263502	20
2005-2014	1,044277	0,0129105	446	1,296991	0,0790867	932

Table 40: Control group employment growth according to year for the pharmaceutical and IT-service industries

For the overall control group the financial crises can be detected and the growth rates are exceptionally low, both for the pharmaceutical and IT-service industry. The differences in average employment growth rates are especially interesting when looking at the overall dataset. A difference of over 13% can be measure at a significance level of just over 5%, when looking at the average of years 1 to 5 after filing.

Group	Overall							
	Difference	Std Error	Degrees of F.	Pr(T > t)				
1-5	0,1311154	0,0811213	4.191	0,0531				
1-10	0,0841387	0,0723133	5.072	0,1223				
Group	Pharmaceutical				IT-Services			
	Difference	Std Error	Degrees of F.	Pr(T > t)	Difference	Std Error	Degrees of F.	Pr(T > t
1-5	0,0437561	0,0589121	1.110	0,2289	0,1293668	0,1104289	3.079	0,120
1-10	0,053281	0,0569903	1.297	0,175	0,062887	0,0977883	3.773	0,260

Table 41: Differences in employment growth rates

Another interesting observation is the pharmaceutical industry. Comparing the difference in average growth rates of the years 1 to 5 and years 1 to 10 after a filing, ones notices that the difference is rising. This is in strong contrast to the IT-service industry and an interesting observation even though it is not significant.

Based on the results from the simple comparison of growth rates, a first conclusion can be drawn. Looking at the two industries, especially the IT-service companies stand out. For them the filing of a trademark has a bigger impact and the growth rates are higher compared to the case when no trademark was filed. Based on the assumption that growth rates imply differentiation and innovation, this implies that trademarks can be used as an indicator of innovation in IT-services, respectively in KIBS.

Growth Analysis by Trademark Type

After the general growth analysis, the next part compares different types of trademarks and derives conclusions from it. First sales, afterwards employment rates are computed.

Sales Growth

Firstly, the type of trademarks are analysed for the whole dataset. Word trademarks are the most used form overall. Comparing the growth figures, one directly notices that word trademarks have the highest rates of all type with 27% on average. Figurative have the second highest average sales rates, but 10% less than word trademarks.

	Overall		
Word			
Year	Mean	Std Error	Observations
1-5	1,339262	0,1668019	1351
6-10	1,087409	0,0185647	486
1-10	1,272631	0,122786	1.837
Figurative			
1-5	1,213539	0,0635363	589
6-10	1,108547	1,108547	313
1-10	1,177106	0,0430264	902
Other			
1-5	0,987840	0,0189939	8
6-10	1,053992	0,0257748	14
1-10	1,029937	0,0188059	22

Table 42: Sales growth rates by trademark type for the dataset

The other types of trademarks experience very little sales growth after filing with an average of only 2,99%. Moreover, the filings are very rare with only 22 observations.

	Pharmaceutical			IT-Services		
Word						
Year	Mean	Std Error	Observations	Mean	Std Error	Observations
1-5	1,109734	0,0257426	422	1,443526	0,2422538	929
6-10	1,106024	0,0619748	119	1,081373	0,014243	367
1-10	1,108918	0,0242409	541	1,340972	0,173732	1.296
Figurative						
1-5	1,066723	0,0133210	219	1,300438	0,1006136	370
6-10	1,082532	0,0574744	145	1,131001	0,0353364	168
1-10	1,073020	0,0242133	361	1,247528	0,0701190	538
Other						
1-5	0,987840	0,0189939	8			
6-10	1,053992	0,0257748	14			
1-10	1,029937	0,0188059	22	-	-	-

Table 43: Sales growth rates by trademark type for the pharmaceutical and IT-service industries

Differentiating by industries confirms the overall findings. However, the differences in the pharmaceutical industry are not as strong between word and figurative. An explanation for this phenomenon might be that the combination of word and figurative trademarks is much higher in the pharmaceutical industry and hence, the difference in sales growth are smaller.

Employment Growth

Performing the same analysis with employment growth results in a different outcome. Looking at the complete dataset is becomes clear that the figurative trademarks achieve higher growth, but only by 1% and furthermore, with a much higher volatility.

	Overall		
Word			
Year	Mean	Std Error	Observations
1-5	1,341668	0,0477032	2400
6-10	1,141244	0,0342244	786
1-10	1,292223	0,036942	3.186
Figurative			
1-5	1,337522	0,0962083	1085
6-10	1,237256	0,1381528	449
1-10	1,308174	0,0791408	1534
Other			
1-5	0,997460	0,0347479	13
6-10	1,015364	0,0126391	21
1-10	1,008518	0,0151647	34

Table 44: employment growth rates by trademark type for the dataset

Other trademarks hardly achieve any growth (0,85%) and are rarely used. Separating by industry, word trademarks are more effective for pharmaceutical companies, while in the IT-service industry figurative trademarks experience the highest growth. This is an interesting finding, which cannot be confirmed by any other results. In comparison to the sales growth rates, both word and figurative trademarks achieve higher growth, while in the pharmaceutical industry the growth rates are lower.

	Pharmaceutical			IT-Services		
Word						
Year	Mean	Std Error	Observations	Mean	Std Error	Observations
1-5	1,094810	0,0532959	591	1,422317	0,0607327	1809
6-10	1,135349	0,0831874	172	1,142895	0,0371398	614
1-10	1,103949	0,045321	763	1,351510	0,046371	2.423
Figurative						
Year	Mean	Std Error	Observations	Mean	Std Error	Observations
1-5	1,036494	0,0177553	314	1,460120	0,1349734	771
6-10	1,080222	0,0617300	182	1,344298	0,2284363	267
1-10	1,052539	0,0252659	496	1,430328	0,116160	1038
Other						
Year	Mean	Std Error	Observations	Mean	Std Error	Observations
1-5	0,997460	0,0347479	13			
6-10	1,015364	0,0126391	21			
1-10	1,008518	0,0151647	34	-	-	-

Table 45: employment growth rates by trademark type for the pharmaceutical and IT-service industries

In general the results show that there are substantial difference between trademarks and that these differences can predict innovation in a better or worse way. Word and figurative trademarks are suitable indicator of innovation for both industries. While the word trademarks are better applicable in the pharmaceutical sector, for IT-service companies the results are mixed and decision between the two trademark types cannot be made. Other trademarks are unsuitable as an indicator since they are hardly used and do not predict any outstanding growth.

Growth Analysis by Size

As a next part the possibility to measure innovation through trademarks is examined in small companies with less than 101 employees. For simplicity reasons, only the average growth rates are considered regarding the trademark as well as the control group.

Sales Growth

Firstly, a growth analysis by the year since filings is conducted. In comparison to the overall dataset the mean growth rates are higher overall and for each industry. Furthermore, IT-service companies experience stronger growth in the first five years experience than the second ones. The difference for IT-services between the first and the last 5 years amounts to almost 40%.

Trademark Group / SMB			
Sales Growth	Overall		
year	Sales Growth	Std Error	Observations
1-5	1,411128	0,2220404	1013
6-10	1,098385	0,231372	360
1-10	1,329127	0,163954	1.373

Table 46: Sales growth according to years after filing of trademark for the all SMBs

Trademark Group / SMBs						
Sales Growth	Pharmaceuticals			IT-Services		
year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
1-5	1,156964	0,0520477	213	1,474827	0,2773715	810
6-10	1,186898	0,1130216	64	1,079248	0,0139825	296
1-10	1,164139	0,047853	267	1,368957	0,203207	1.106

Table 47: Sales growth according to years after filing of trademark for SBMS pharmaceutical and IT-service companies

For the pharmaceutical industry it is the other way round. Like previous results, the growth rates are stronger within years 6 to 10. Overall the IT-services industry has higher growth rates compared to the pharmaceutical industries: however, year 6 – 10 are stronger for pharmaceuticals .

Next, the growth rates for the control group are computed and then compared to the trademark group. While none of the differences are statistically significant, implications from the results can be drawn. Firstly, the small pharmaceutical companies have less sales growth compared to the control group.

Control Group / SMB			
Sales Growth	Overall		
year	Sales Growth	Std Error	Observations
2006-2014	1,269426	0,090218	539

Control Group / SMB						
Sales Growth	Pharmaceutical			IT-Services		
year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
2006-2014	1,307050	0,258969	120	1,258650	0,089481	419

Table 48: Control group sales growth according to year for SMB pharmaceutical and IT-service companies

Group	Overall			
	Difference	Std Error	Degrees of F.	Pr(T > t)
1-5	0,1417029	0,3114718	1.550	0,3246
1-10	0,059702	0	1.910	0,4118

Group	Pharmaceutical				IT-Services			
	Difference	Std Error	Degrees of F.	Pr(T > t)	Difference	Std Error	Degrees of F.	Pr(T > t)
1-5	-0,1500862	0,210113	321	0,2378	0,2161764	3910573	1.227	0,2903
1-10	-0,142911	0,1874779	385	0,2232	0,110307	0,3347729	1.523	0,3709

Table 49: Differences in sales growth rates for SMBs

For the small IT-service companies the contrary is true and in the first five years after filing they experience over 20% more growth than small companies that do not file a trademark. These results confirm the previous results from the general growth analysis and that trademark filings also result in strong growth for small IT-services. For small pharmaceutical companies on the other hand the relation between trademarks and growth cannot be proven.

Employment Growth

The following part is devoted to the growth analysis of small companies. Similar to the results for sales growth, the average rate is higher by 3% compared to the whole trademark group; however, the standard error stays almost the same. Compared to the sales results for the SMBs the average rates are almost the same with differences smaller than 1%.

Trademark Group / SMB			
Emp Growth	Overall		
year	Sales Growth	Std Error	Observations
1-5	1,375971	0,0459721	2029
6-10	1,173338	0,048515	623
1-10	1,328369	0,0370064	2652

Table 50: employment growth according to years after filing of trademark for all SMBs

Trademark Group / SMB						
Emp Growth	Pharmaceutical			IT-Services		
year	Emp Growth	Std Error	Observations	Emp Growth	Std Error	Observations
1-5	1,134967	.089968	349	1,426037	.0522096	1680
6-10	1,205989	.1336871	104	1,166795	.0517687	519
1-10	1,151272	.0757503	453	1,364852	.0417774	2199

Table 51: employment growth according to years after filing of trademark for SMB pharmaceutical and IT-service companies

The same applies to the separate industries. The sales results are confirmed by the employment analysis meaning that the first 5 years experience higher growth than the last 5 in the IT-service sector; again the contrary is true for pharmaceutical companies. Comparing the average growth rates of the trademark group with the results for SMBs of the control show that most of the figures are in the line with the SMBs sales results. Nevertheless, two interesting results come to light.

Control Group / SMB			
Emp Growth	Overall		
year	Emp Growth	Std Error	Observations
2006-2014	1,229713	0,054967	984

Control Group / SMB						
Emp Growth	Pharmaceutical			IT-Services		
year	Emp Growth	Std Error	Observations	Emp Growth	Std Error	Observations
2006-2014	1,036841	0,020228	247	1,294352	0,072934	737

Table 52: Control group employment growth according to year for the pharmaceutical and IT-service industries

Group	Overall / SMB			
	Difference	Std Error	Degrees of F	Pr(T > t)
1-5	0,1462585	0,0763111	3.011	0,0277
1-10	0,098657	0,0693691	3.634	0,0775

Group	Pharmaceutical / SMB				IT-Services / SMB			
	Difference	Std Error	Degrees of F	Pr(T > t)	Difference	Std Error	Degrees of F	Pr(T > t)
1-5	0,0981264	0,1083134	594	0,1827	0,1316846	0,0924518	2.415	0,0772
1-10	0,114432	0,1036987	698	0,1351	0,070499	0,0836086	2.934	0,1996

Table 53: Differences in employment growth rates for SMB

Firstly, the difference in averages between the control group for the overall dataset as well as IT-service sector group for the years 1 to 5 years are both significant at a 5%, respectively, 10% level. Secondly, the difference for the pharmaceutical industry is positive, which was not the case for the sale growth rates. Interestingly, sales growth is higher for the control group while employment growth is higher for the trademark group within SMBs of the pharmaceutical industry.

In summary, trademarks seem to be a good indicator for innovation in small companies, especially when looking at the IT-service industry, where the results are conclusive and pointing towards good usability. However, results for pharmaceutical SMBs are inconclusive. While sales growth does not and employment growth supports the usability of trademarks.

Growth Analysis by Age

After examining SMBs, the next step is to have a closer look at different age groups of companies and how age affects growth rates and the possibility to use trademarks as an indicator of such. For the age analysis the two groups defined in the descriptive analysis are combined and young companies are classified between the age of zero to ten years.

Sales Growth

Looking at the sales growth rates an interesting picture is revealed. Firstly, the growth rates are high, but not as high as the ones of the complete dataset and secondly, the difference between the two industries becomes smaller. While the average rate of pharmaceutical companies rises by 3%, the one of IT-services decreases by almost 5%. Thirdly, the growth rates from year 1 to 5 are for the first time higher than year 6 to 10 for the pharmaceutical company.

	Overall		
year	Sales Growth	Std Error	Observations
1-5	1,277746	0,0433564	630
5-6	1,126403	0,0291165	190
1-10	1,242678	0,034051	820

Table 54: sales growth according to years after filing of trademark for young companies

	Pharmaceutical			IT-Services		
year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
1-5	1,139675	0,0708832	88	1,300163	0,0490159	542
5-6	1,098222	0,0656523	25	1,130673	0,0320721	165
1-10	1,130504	0,056977	113	1,260607	0,038398	707

Table 55: sales growth according to years after filing of trademark for young from the pharmaceutical and IT-service industry

Fourthly, the growth rates of the control group are strictly higher than the trademark group, overall and for both industries. These results are in strong contrast to the growth rates results when not differentiating by age.

Control Group / young			
Sales Growth	Overall		
year	Sales Growth	Std Error	Observations
2006-2014	1,354977	0,119671	304

Control Group / SMB						
Sales Growth	Pharmaceutical			IT-Services		
year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
2006-2014	1,189050	0,083956	34	1,375872	0,134310	270

Table 56: Control group sales growth according to year for young companies from the pharmaceutical and IT-service industry

Group	Overall / young			
	Difference	Std Error	Degrees of F	Pr(T > t)
1-5	-0,3499218	0,2385473	371	0,0716
1-10	-0,383118	0,2252352	404	0,0449

Group	Pharmaceutical / young				IT-Services / young			
	Difference	Std Error	Degrees of F	Pr(T > t)	Difference	Std Error	Degrees of F	Pr(T > t)
1-5	-0,2591365	0,36447	45	0,2404	-0,3347373	0,2646161	324	0,1034
1-10	-0,261014	0,3553823	47	0,2332	-0,375783	0,2484393	355	0,0656

Table 57: Differences in sales growth rates for young companies

Hereby, all differences in growth rates are significant at least at a 10% level, except year 1 to 5 of the IT-service sector, even though the difference is high with over 33%. However, it is important to notice that the standard error of the young company control group is very high and higher than the young companies of the trademark group. This can be interpreted as a stabilizing effect of trademarks on sales growth rates in early years of a company, yet at a lower level.

Employment Growth

The employment growth rates of young companies contrast the sales growth in a strong way. The average growth rates of employment are much higher than sales. For pharmaceutical companies, the first years have relatively low growth and acceleration takes place in the last year, while the opposite is true for IT-service companies, thereby confirming the results derived form the complete dataset.

	Overall		
year	Sales Growth	Std Error	Observations
1-5	1,589853	0,0984407	1,351
5-6	1,291968	0,0987722	304
1-10	1,535136	0,082419	1.655

Table 58: employment growth according to years after filing of trademark for young companies

	Pharmaceutical			IT-Services		
year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
1-5	1,081321	0,0295787	136	1,646775	0,1092931	1215
5-6	1,614388	0,4034079	29	1,257967	0,1006393	275
1-10	1,175011	0,075683	165	1,575015	0,091108	1.490

Table 59: employment growth according to years after filing of trademark for young companies from the pharmaceutical and IT-service industry

The standard error is relatively high for both groups, trademark and control, which makes sense regarding the high-risk nature of young companies.

Control Group / young			
Emp Growth	Overall		
year	Emp Growth	Std Error	Observations
2006-2014	1,359146	0,093684	569

Control Group / SMB						
Emp Growth	Pharmaceutical			IT-Services		
year	Emp Growth	Std Error	Observations	Emp Growth	Std Error	Observations
2006-2014	1,095361	0,043049	87	1,406758	0,110201	482

Table 60: Control group employment growth according to year for young companies from the pharmaceutical and IT-service industry

Group	Overall / young			
	Difference	Std Error	Degrees of F	Pr(T > t)
1-5	0,2307077	0,1634303	1.918	0,0791
1-10	0,175990	0,1509263	2.222	0,1219

Group	Pharmaceutical / young				IT-Services / young			
	Difference	Std Error	Degrees of F	Pr(T > t)	Difference	Std Error	Degrees of F	Pr(T > t)
1-5	-0,0140403	0,0505212	221	0,6093	0,2400172	0,1869074	1.695	0,0996
1-10	0,079650	0,1088925	250	0,2326	0,168257	0,1682574	1.970	0,1641

Table 61: Differences in employment growth rates for young companies

The differences are normally positive, indicating bigger rates by young companies from the trademark group. Nevertheless growth rates of control pharmaceutical companies are higher by 1% in the first five years after filing a trademark, but this changes in when looking at the whole 10 years. Significant differences are the 1 to 5 years after for the overall group and the IT-services.

Summing up the results of the young company analysis, a contradictory picture was formed. On the one hand, sales figures do not indicate any usefulness of trademarks as an indicator since the control group achieves higher growth compared to the trademark group. One the other hand the employment results indicate such usefulness as and indicator because the results are the other way round. A potential explanation for the different in results for pharmaceuticals and IT-services is the nature of young companies and the meaning of growth in sales versus employment. Young companies operate in a high-risk environment and sales growth is especially volatile. While good performance and strong growth is captured by the company information, weak sales growth in case of bankruptcy is not captured since no further sales information are provided on which basis growth calculations could be made. This explanation is supported by the findings from the descriptive analysis regarding the sales per trademark. The volatility is especially high for companies with few trademarks. Employment growth for young companies on the other hand is more stable and does not adopt as quickly as sales growth. The results implies that trademarks might be an indicator of innovation for young companies; however, further research in this area has to be conducted and possible adjustments for young companies tested.

Growth Analysis of Trademarks and Patents

Lastly the influence of combined usage of different IPRs will be examined for the dataset. Hereby, three different groups will be distinguished: 1) companies with trademarks and patents 2) companies with trademarks only 3) companies with patents only. The results are discussed in the following part.

Sales growth

Firstly, an overview over the whole dataset is given in table 62. Comparing the different groups shows that the group with companies that which only have trademarks is the biggest, while the groups with only patents and trademarks and patents have a similar number companies. Interestingly, the group of companies that combine trademarks and patents have the lowest growth rates on average and the companies, which only have trademarks experience the strongest growth with more than 5% difference.

Sales growth		Overall		
Group	year	Sales Growth	Std Error	Observations
Trademark & Patent	1-5	1,117102	0,0248586	431
	5-6	1,127318	0,0575061	140
	1-10	1,119607	0,023444	571
Only Trademark	1-5	1,387604	0,2036937	1.105
	5-6	1,083863	0,0142643	419
	1-10	1,304095	0,147766	1.524
Only Patent	2006-2014	1,251057	0,082292	654

Table 62: Comparison of sales growth by patent and trademark groups

Sales growth		Pharmaceutical			IT-Services		
Group	year	Sales Growth	Std Error	Observations	Sales Growth	Std Error	Observations
Trademark & Patent	1-5	1,107672	0,0324645	270	1,132916	0,0383635	161
	5-6	1,171579	0,1087579	72	1,080454	0,0280972	68
	1-10	1,121126	0,034305	342	1,117338	0,028241	229
Only Trademark	1-5	1,104897	0,0349318	188	1,445564	0,2453291	917
	5-6	1,042300	0,0306887	58	1,090540	0,0157910	361
	1-10	1,090138	0,027682	246	1,345279	0,176116	1.278
Only patent	2006-2014	1,168536	0,134077	232	1,296424	0,104125	422

Table 63: Comparison of sales growth by patent and trademark groups for the pharmaceutical and IT-service industries

The assessment by industry reveals further interesting insights. The strongest growth in the pharmaceutical industry is achieved by companies, which only have patents. In contrast IT-service companies with only have trademarks have the highest growth rates, almost twice as much as any pharmaceutical group.

Group	Overall				Sales Only Trademarks versus Only Patents			
	Difference	Std Error	Degrees of F	Pr(T > t)				
1-10	0,053038	0,2319453	2.176	0,4096				
Group	Pharmaceutical				IT-Services			
	Difference	Std Error	Degrees of F	Pr(T > t)	Difference	Std Error	Degrees of F	Pr(T > t)
1-10	-0,078398	0,1332824	476	0,2783	0,048855	0,3123233	1.698	0,4379

Table 64: Comparison of difference in sales growth for only patent and only trademark group

While no differences are significant, table 64 provides interesting insights about the impact of IPRs on sales growth. While patents seems to be the better indicator for pharmaceutical, IT-service companies rely more on trademarks and its usage better illustrates innovation reflected through growth.

Employment growth

Similar to the sales growth results, the combined trademark and patent group experiences the smallest growth among the three and the group with companies which only use trademarks the strongest.

Sales growth		Overall		
Group	year	Emp Growth	Std Error	Observations
Trademark & Patent	1-5	1,152508	0,0568324	652
	5-6	1,091559	0,0462146	204
	1-10	1,137983	0,044663	856
Only Trademark	1-5	1,404733	0,0631216	2.163
	5-6	1,166615	0,0465637	677
	1-10	1,347970	0,049372	2.840
Only patent	2006-2014	1,175110	0,054548	1.101

Table 65: Comparison of employment growth by patent and trademark groups

Sales growth		Pharmaceutical			IT-Services		
Group	year	Emp Growth	Std Error	Observations	Emp Growth	Std Error	Observations
Trademark & Patent	1-5	1,025926	0,0113086	373	1,321737	0,1314025	279
	5-6	1,056155	0,0521523	97	1,123654	0,0744628	107
	1-10	1,032165	0,013990	470	1,266828	0,097239	386
Only Trademark	1-5	1,167098	0,1067498	293	1,441967	0,0710400	1870
	5-6	1,212662	0,1490379	90	1,159555	0,0486495	587
	1-10	1,177805	0,088774	383	1,374496	0,055351	2.457
Only patent	2006-2014	1,045688	0,014495	368	1,240085	0,081523	733

Table 66: Comparison of employment growth by patent and trademark groups for the pharmaceutical and IT-service industries

Examining the groups separately by industry, some differences are revealed. Firstly, the highest growth among the different groups is for both industries achieved by the groups of companies that only use trademarks. The second highest growth rates varies by industries. While the differences are quite low, the combined usage of trademark and patents performed better in the IT-service industry and than the sole usage of patents, it is the other way round in the pharmaceutical industry.

Group	Overall				Employment Only Trademarks versus Only Patents			
	Difference	Std Error	Degrees of F	Pr(T > t)				
1-10	0,172861	0,0862658	3.939	0,0226				
Group	Pharmaceutical				IT-Services			
	Difference	Std Error	Degrees of F	Pr(T > t)	Difference	Std Error	Degrees of F	Pr(T > t)
1-10	0,132117	0,0916755	749	0,0750	0,134411	0,1106944	3.188	0,112

Table 67: Comparison of difference in sales growth for only patent and only trade-mark group

In contrast to the sales growth, the differences between isolated usage of patents and trademarks significant for the industries combined as well as the pharmaceutical industry.

In conclusion, the results for the pharmaceutical industry are inconclusive for the combined data of patents and trademarks. While patents better indicate innovation through sales growth, trademarks are superior regarding employment information. However, the usage of trademarks as an indicator of innovation seems highly effective for IT-service companies confirmed by sales as well as employment. Interestingly, the combination of patents and trademarks in neither industry is a good indicator of potential growth.

Conclusion

The aim of this study was to examine the usefulness of trademarks as a complementary indicator of innovation based on evidence from the German pharmaceutical and IT-service industries. In order to test the potential application of trademarks as an indicator, a new approach was developed. Instead of relying purely on the correlation between patents and trademarks, growth analyses were conducted based on sales and employment. The rational is that the majority of new trademarks are only registered if they are linked to an innovation new to the company and that this innovation can be measured in sales and employment growth (Mendonça, Pereira, and Godinho, 2004). Furthermore, a special attention was given to KIBS. KIBS industries were adversely affected by previous indicators of innovation because they make little R&D investments and hold patents. Thus, using trademarks is a way to better understand innovativeness within such companies.

The results found in this study support the usage of trademarks as an indicator of innovation with limitations. The descriptive analysis shows that a strong correlation between patents and trademarks can be found for the pharmaceutical industry indicating a connection between innovation and trademarks. Employment growth confirms the connection between trademarks and innovation and finds that pharmaceutical companies of the trademark group achieve higher employment growth compared to the control group. However, these results cannot be confirmed by the sales growth analysis, where the control group achieves significantly higher growth rates.

In contrast to the findings for the pharmaceutical industry are the results of the IT-service industry. While no correlation between patents and trademarks can be found, these IT-service companies rely relatively stronger on trademarks, which is potentially a result of their nature as a service business. Furthermore, the growth rates for sales and employment confirm the thesis that trademarks are filled for products with a major differentiation compared to the market. In both cases the trademark group experiences higher growth rates and especially in the first five years the difference to the control group is substantial.

A classification of trademarks shows that 3D, colour and sound trademarks do not provide insights about growth. Only world and figurative ones have an impact on growth and indicate a connection to innovation. However, it becomes clear that there are substantial differences in trademarks and that these differences could provide further insights.

The refined analyses for size and age paint an inconclusive picture. The results for small companies confirm the findings of the general growth analyses and determine the usefulness of trademarks as an indicator for innovation in small IT-service companies, the findings for small pharmaceutical companies are mixed. While employment growth confirms the connection to innovation, sales growth shows gives negative results. Regarding the age analysis, not connection between sales growth and trademarks can be proven for pharmaceutical as well as IT-service companies. A potential explanation for these findings is the high-risk nature of young companies and that only the positive growth cases are captured. The high volatility and employment growth support this explanation. Trademarks reduce the fluctuation in sales growth for young companies and the more stable and long-term oriented employment growth hast higher rates compared to the control group. Nevertheless, further studies about the impact of trademarks on small companies should be conducted in order to get a better understanding.

As a last part the combined influence of patents and trademarks on growth was examined. The results show that pharmaceutical companies, which hold patents, experience the strongest growth. The contrary is true for the IT-service industry. Here companies, which only have trademarks, experience the highest growth. This is confirmed by the employment growth statistics.

The overall results demonstrate the superiority of trademarks as an indicator of innovation compared to patents for the IT-service industry. Sales as well as employment growth are higher after the filing of a trademark and the results are in line with previous findings for KIBS (Gotsch and Hipp, 2012; Hipp and Grupp, 2005; Schmoch and Gauch, 2009). Ambiguous results are only found for young companies.

Regarding the pharmaceutical industry, a differentiation between sales and employment growth has to be made. While sales growth does not confirm the usefulness of trademarks, the opposite is true for employment. A potential explanation for this might be the long development times of pharmaceutical products and hence the longer planning horizon in the pharmaceutical industry. Evidence for this are the sales growth rates, which accelerate in the years 6 to 10. Also the results for employment growth support the explanation since employment is a more long-term oriented figure.

In general the usefulness of trademarks as an innovation indicator can be confirmed and the findings are in line with previous studies (Malmberg, 2005; Mendonça, Pereira, and Godinho, 2004; Millot, 2009). Nevertheless, differentiations have to be made regarding the application of different industries or the age of companies.

Future Research

This study of trademarks as an indicator of innovation provides interesting results; however, it has several limitations and produces some inconclusive outcomes. Firstly, an examination of the timing of the filing of trademarks within the pharmaceutical industry may refine the results of this study. There are evidence that sales growth rates pick up at a later stage, which can be used to examine the connection between trademarks and sales growth.

Furthermore, the evidences for young companies are ambiguous and more in depth analysis for these companies would help to gain a better understanding of the influence of trademarks. Especially sales growth is a flawed indicator for young companies since only the positive variation in is captured and the case of bankruptcy not covered. An analysis of survival rates might help to gain better insights into a potential connection with trademarks and innovation.

Furthermore, a more refined classification of trademarks might provide further insights as can be deduced from the type analysis of trademarks. One possible differentiation could be along brand identification and brand association trademarks as proposed by Krasnikov, Mishra and Orozco, (2009). Also the classification of a trademark according to its value might provide a better understanding. A proxy to determine the value could be the number of oppositions of a trademark.

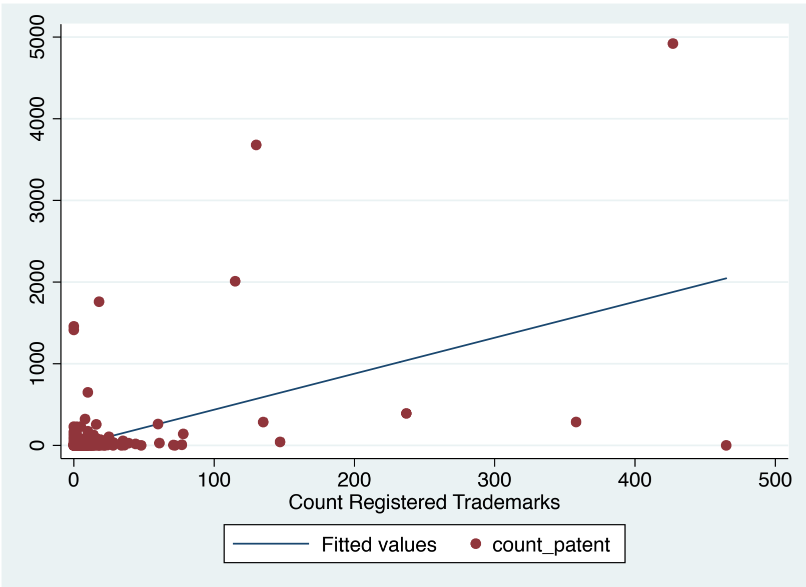
Lastly, the connection between filled trademarks and the share of revenue with new products could help to better understand the connection to innovation.

Appendix

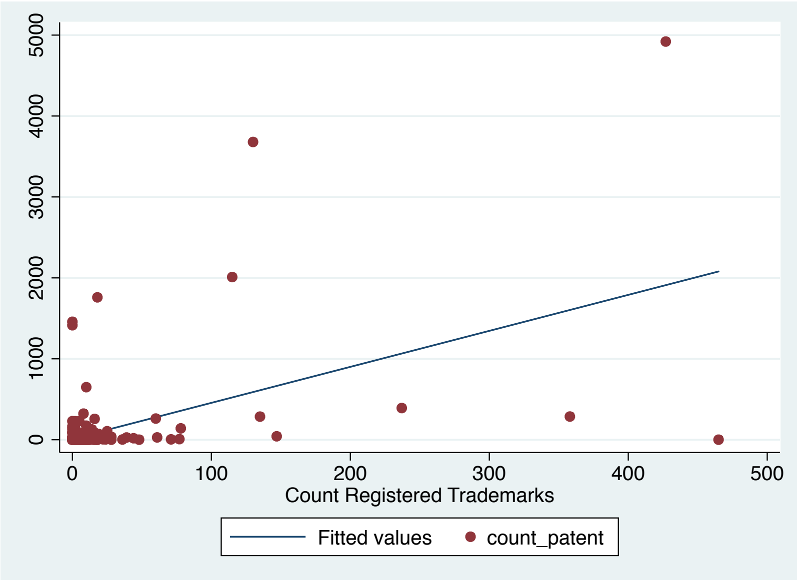
Appendix 1: Companies with patents by industry and group

Group	Industry	Companies with Patents	# Valid Patents
Trademark Group	Pharmaceutical	146	17714
	IT services	130	596
	Overall	276	18310
Control Group	Pharmaceutical	126	4065
	IT services	218	467
	Overall	344	4532

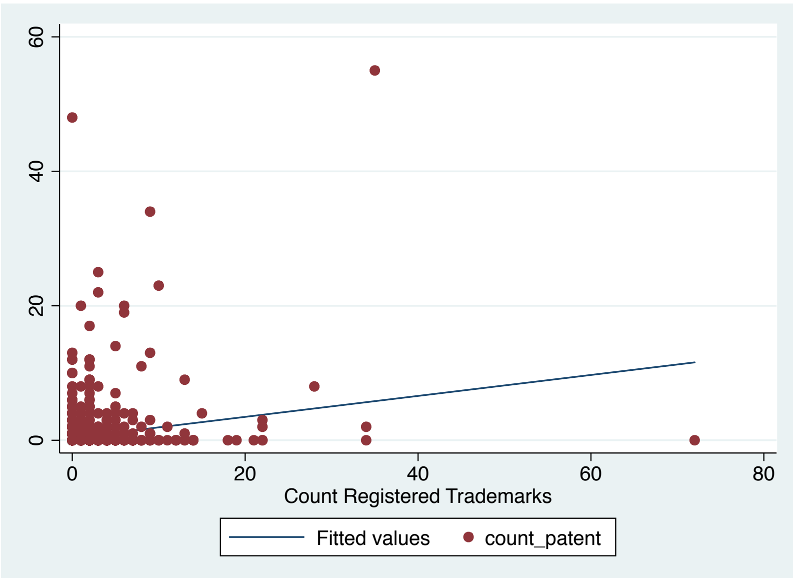
Appendix 2: Scatter graph of patent count and trademark count for the dataset



Appendix 3: Scatter graph of patent count and trademark count for the pharmaceutical industry



Appendix 4: Scatter graph of patent count and trademark count for the IT-service industry



Appendix 5: Overall trademark distribution by age

Year 2014	Overall		
Age Cluster	Trademarks	Std. Error	Observations
0	1,3	0,097353	50
1	1,4	0,092919	166
2	1,6	0,117100	169
3	1,9	0,285974	105
4	3,1	1,064289	68
5	1,7	0,169443	61
6-10	2,3	0,205907	266
10-15	2,8	0,223441	305
15-25	4,9	1,806216	258
25-50	6,0	1,298655	116
50-100	15,7	6,093102	60
>100	47,7	1,845067	27
Mean Age	14,56		
Skewness	5,72		
Kurtosis	39,04		

Appendix 6: Overview Sales cluster

Sales [in 000 €]	Overall		Pharmaceutical		IT Services	
	#	%	#	%	#	%
< 500	197	19,6%	14	6,3%	183	23,3%
[500 - 1.000[	116	11,5%	16	7,1%	100	12,7%
[1.000 - 5.000[	350	34,8%	48	21,4%	302	38,4%
[5.000 - 10.000[	123	12,2%	29	12,9%	94	12,0%
[10.000 - 100.000[	168	16,7%	68	30,4%	100	12,7%
[100.000 - 1.000.000[	36	3,6%	31	13,8%	5	0,6%
[1.000.000 - 10.000.000[	14	1,4%	15	6,7%	2	0,3%
> 10.000.000	3	0,3%	3	1,3%	0	0,0%
-	660		71		589	
Total	1.667	100%	295	100%	1.375	100%
Mean Sales	125.795		530.455		12.017	

Appendix 7: Employment distribution

Emp	Overall		Pharmaceutical		IT Services	
	#	%	#	%	#	%
1	238	14,3%	23	7,9%	215	15,6%
2	187	11,2%	14	4,8%	173	12,6%
3 -5	173	10,4%	19	6,5%	154	11,2%
6-10	164	9,8%	18	6,2%	146	10,6%
11-50	488	29,3%	81	27,7%	407	29,6%
51-100	140	8,4%	29	9,9%	111	8,1%
101-1000	172	10,3%	76	26,0%	96	7,0%
>= 1001	30	1,8%	26	8,9%	4	0,3%
-	75	4,5%	6	2,1%	69	5,0%
Total	1.667	100%	292	100%	1.375	100%
Mean	236		1.131		40	

Appendix 8: Linear regression of employment per trademark by trademark group for the overall dataset and by industry

Overall			
emp_ntrade	Coef.	Std. Err.	P>t
ntrade	0,25	0,1398	0,072
_cons	29,43	2,9648	0,000

Number obs	1.592
R-squared	0,0020

Pharmaceutical				IT-Service			
emp	Coef.	Std. Err.	P>t	emp	Coef.	Std. Err.	P>t
ntrade	0,09	0,2636	0,730	ntrade	-0,66	0,6283	0,294
_cons	68,69	12,9783	0,000	_cons	23,29	2,5869	0,000

Number obs	286
R-squared	0,0004

Number obs	1.306
R-squared	0,0008

Literature

Aaker, David A. (1991). "Managing Brand Equity: Capitalizing on the Value of a Brand Name."

Albert, M B, D Avery, F Narin, and P McAllister. (1991). "Direct Validation of Citation Counts as Indicators of Industrially Important Patents." *Research Policy* 20: 251–59.

Allegrezza, Serge, and Alexandra Guard-Rauchs. (1999). "The Determinants of Trademark Deposits: An Econometric Investigation (a Case Study of the Benelux)." *Economie Appliquée* 52(2): 51–68.

Arundel, Anthony, Minna Kanerva, Adriana Van Cruysen, and Hugo Hollanders. (2007). *Innovation Statistics for the European Service Sector.*

Bloom, Nicholas, and John Van Reenen. (2002). "Patents, Real Options and Firm Performance." *The Economic Journal* 112: C97–116.

Brouwer, Erik, Alfred Kleinknecht, and Jeroen O.N. Reijnen. (1993). "Employment Growth and Innovation at the Firm Level." *Journal of Evolutionary Economics* 3: 153–59.

Carden, Steven D, Lenny T. Mendonca, and Tim Shavers. (2005). "What Global Executives Think about Growth and Risk." *McKinsey Quarterly* (2): 16–25.

Chandler, Alfred D. (1994). "The Competitive Performance of U. S. Industrial Enterprises since the Second World War." *The Business History Review* 68(1): 1–72.

Coad, Alex. (2009). *The Growth of Firms - A Survey of Theories and Empirical Evidence*. Cheltenham: Edward Elgar Publishing.

Coad, Alex, and Rekha Rao. (2008). "Innovation and Firm Growth in High-Tech Sectors: A Quantile Regression Approach." *Research Policy* 37(4): 633–48.

Cohen, Wesley M., Rirchard R. Nelson, and John P. Walsh. (2000). *Protecting Their Intelelctual Assets: Appropriability Condictions and Why U.S. Manufacturing Firms Patent (or Not)*. NBER working paper 7552.

Djellal, Faridah, and Faïz Gallouj. (1999). "Services and the Search for Relevant Innovation Indicators: A Review of National and International Surveys." *Science and Public Policy* 26(4): 218–32.

Economides, NS. (1988). "Economics of Trademarks, The." *Trademark Reporter* 78: 523–39.

European Council. (1993). *Council Regulation No. 40/94 of 20 December*

1993 on the Community Trade Mark. Brussels: Council of the European Union.

Geroski, Paul, and Steve Machin. (1992). “Do Innovating Firms Outperform Non-Innovators.” *Business Strategy Review* 3(2): 79–90.

Gotsch, Matthias, and Christiane Hipp. (2012). “Measurement of Innovation Activities in the Knowledge-Intensive Services Industry: A Trademark Approach.” *The Service Industries Journal* 32(13): 2167–84.

Grabowski, Henry, John Vernon, and Joseph DiMasi. (2002). “Returns on Research and Development for 1990s New Drug Introductions.” *Pharmacoeconomics* 20(3): 11–29.

Greenhalgh, Christine, and Mark Rogers. (2012). “Trade Marks and Performance in Services and Manufacturing Firms : Evidence of Schumpeterian Competition through Innovation.” *The Australian Economic Review* 45(1): 50–76.

Griffiths, William, Paul H Jensen, and Elizabeth Webster. (2011). “What Creates Abnormal Profits?” *Scottish Journal of Political Economy* 58(3): 323–47.

Griliches, Zvi. (1984). *R&D, Patent and Productivity*. Chicago: University of Chicago Press.

Guerrero-Cusumano, J. L., and S. McGuire. (2001). “Effects of National Culture on Economic Creativity and Innovation.” In *Proceedings of the 2001 International Research MAAOE Conference*,.

Hall, Bronwyn H. (2000). “Innovation and Market Value.” In *Productivity, Innovation and Economic Performance*, eds. R. Barrell, G. Mason, and M. O’Mahony. , 177–89.

Hall, Bronwyn H., Adam Jaffe, and Manuel Trajtenberg. (2005). “Market Value and Patent Citations.” *The RAND Journal of Economics* 36(1): 16–38.

Harrison, Rupert, Jordi Jaumandreu, Jacques Mairesse, and Bettina Peters. (2014). “Does Innovation Stimulate Employment? A Firm-Level Analysis Using Comparable Micro-Data from Four European Countries.” *International Journal of Industrial Organization* 35: 29–43.

Hartshorn, James, and David Wheeler. (2002). “Facilitating Strategic Business Responses to Sustainability.” *Greener Management International* 40(Winter): 107–19.

Hay, Michael, and Kimya Kamshad. (1994). “Small Firm Growth: Intentions, Implementation and Impediments.” *Business Strategy Review* 5(3): 49.

Hipp, Christiane, and Hariolf Grupp. (2005). “Innovation in the Service Sector: The Demand for Service-Specific Innovation Measurement Concepts and Typologies.” *Research Policy* 34: 517–35.

Hunt, Shelby D., James A. Muncy, and Nina M. Ray. (1981). “Aiderson’s General Theory of Marketing: A Formalization.” *Review of Marketing*: 267–72.

Klette, Tor Jakob, and Zvi Griliches. (2000). “Empirical Pattern of Firm Growth and R&D Investment: A Quality Ladder Model Interpretation.” *The Economic Journal* 110(April): 363–87.

Krasnikov, Alexander, Saurabh Mishra, and David Orozco. (2009). “Evaluating the Financial Impact of Branding Using Trademarks: A Framework and Empirical Evidence.” *Journal of Marketing* 73(November): 154–66.

Levin, Richard C., Alvin K. Klevorick, Richard R. Nelson, and Sidney G. WInter. (1987). “Appropriating the Returns from Industrial Research and Development.” *Brookings Papers on Economic Activity* 3: 783–831.

Lucking, Ben. (2004). *International Comparisons of the Third Community Innovation Survey (CIS3)*.

Malmberg, Claes. (2005). “Trademarks Statistics as Innovation Indicator? - A Micro Study.” *Circle* 17: 1–43.

Mansfield, Edwin. (1962). “Entry, Gibrat’s Law, Innovation, and the Growth of Firms.” *The American Econimic Review* 52(5): 1023–51.

Mendonça, Sandro, Tiago Santos Pereira, and Manuel Mira Godinho. (2004). “Trademarks as an Indicator of Innovation and Industrial Change.” *Research Policy* 33: 1385–1404.

Miles, Ian. (2005). “Knowledge Intensive Business Services: Prospects and Policies.” *Foresight* 7(6): 39–63.

Millot, Valentine. (2009). Working Paper *Trademarks as an Indicator of Product and Marketing Innovations*.

Mowery, David C. (1983). “Industrial Research and Firm Size, Survival, and Growth in American Manufacturing, 1921–1946: An Assessment.” *The Journal of Economic History* 43(04): 953–80.

OECD. (1992). “The Measurement of Scientific and Technological Activities, Porposed Guidlines for Collecting and Interpreting Technological Innovation Data: Oslo Manual.” *OECD*.

———. (2005). *Oslo Manual: Guidelines for Collecting and Interpreting*

Innovation Data. 3rd ed. Paris: OECD Publishing.

OHIM. (2014). “Guidelines for Examination in the Office for Hamonization in the Internal Market (Trade Marks and Designs) on Community Trade Marks, Part D, Cancellation.”

Pakes, Ariel, and Zvi Griliches. (1980). “Patents and R&D at the Firm Level: A First Look.” *Economics Letters* 5(4): 377–81.

Pakes, Ariel, and Mark Schankerman. (1984). “The Rate of Obsolescence of Patents, Research Gestation Lags, and the Private Rate of Return to Research Resources.” In *Zvi Griliches, R&D, Patents, and Productivity*, CHicago: University of Chicago Press, 73–88.

Pavitt, K. (1985). “Patent Statistics as Indicators of Innovative Activities: Possibilities and Problems.” *Scientometrics* 7((1-2)): 77–99.

Van Reenen, John. (1997). “Employment and Technological Innovation: Evi-Dence from UK Manufacturing Fi Rms.” *Journal of Labor Economics* 15(2): 255–84.

Roper, Stephen. (1997). “Product Innovation and Small Business Growth: A Comparison of the Strategies of German, UK and Irish Companies.” *Small Business Economics* 9(6): 523–37.

Sandner, Philipp G, and Joern Block. (2011). “The Market Value of R&D, Patents, and Trademarks.” *Research Policy* 40: 969–85.

Schechter, Frank I. (1927). “The Harvard Law Review Association.” *Harvard Law Review* 40(6): 813–33.

Scherer, F. M. (1965). “Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions.” *The American Econimic Review* 55(5): 1097–1125.

Schmoch, Ulrich. (2003). “Service Marks as Novel Innovation Indicator.” *Research Evaluation* 12(2): 149–56.

Schmoch, Ulrich, and Stephan Gauch. (2009). “Service Marks as Indicators for Innovation in Knowledge-Based Services.” *Research Evaluation* 18(4): 323–35.

Schmookler, Jacob. (1666). *Invention and Economic Growth*. Cambridge, MA: Harvard University Press.

Schumpeter, Joseph A. (1939). 2 *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*. New York: McGraw-HIll.

Seethamraju, Chandrakanth. (2003). “The Value Relevance of Trademarks.” In *Intangible Assets: Values, Measures, and Risks*, eds. J. Hand and B.

Lev. Oxford: Oxford University Press.

Smolny, Werner. (1998). "Innovations, Prices, and Employment – a Theoretical Model and an Empirical Application for West German Manufacturing Firms." *Journal of Industrial Economics* 46(3): 359–81.

Trajtenberg, Manuel. (1990). *Economic Analysis of Product Innovation: The Case of CT Scanners*. Cambridge, MA: Harvard University Press.

Williams, Leslie K., and Stephen J. McGuire. (2010). "Economic Creativity and Innovation Implementation: The Entrepreneurial Drivers of Growth? Evidence from 63 Countries." *Small Business Economics* 34: 391–412.

WIPO. (2004a). "Fields of Intellectual Property Protection." In *WIPO Intellectual Property Handbook: Policy, Law and Use*, , 15–40.

———. (2004b). "What Is Intellectual Property?"

———. (2012). "The Madrid Agreement Concerning the International Registration of Marks and the Protocol Relating to That Agreement: Objectives, Main Features, Advantages."

———. (2014). "WIPO IP Facts and Figures."

Witt, Ulrich. (1993). *Evolutionary Economics: Some Princinples.pdf*. Heidelberg: Physica.