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f â€œsmallâ€• applicants â€“ A comparative study of single inventors, small compar

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Abstract

This paper focuses on the motives for patent applications of small applicant types.

We find that small applicant types generally patent for different reasons than big and established companies do and show that single inventors, small companies and universities do differ in their motivation for patent applications. First, we find regarding small companies the signaling effect of patents to be of high importance. For universities and single inventors we detect significant similarities. Both applicant types attach significantly high importance to the generation of licensing opportunities. However, we find an important difference with respect to the motive of blocking third parties. Whereas universities do significantly not file patents in order to block others, single inventors attribute most importance of all groups to that motive.

We interpret our finding as a high willingness of universities to license out technology. Thus, university patenting could be interpreted as beneficial to markets for technology. Single inventors, in turn, focus on licensing and blocking at the same time. This could be interpreted as patent troll-like behavior. Small companies, however, might benefit from an ease of firms? access to the patent system to improve their access to financial resources.

Jelcodes:O34,O38

1. Introduction

Several studies investigate the puzzling question why we observe so many patent applications. These studies either focus on certain types of patent applicants (e.g. Cohen et al. (2000) on big companies) or certain industries (e.g. Hall and Ziedonis (2001) on the semiconductor industry). A broad empirical analysis comparing the motives of individual inventors, small companies and universities with the motives of well-established, big companies is missing in literature. It has been argued that small applicants are disadvantaged compared to big companies in the current system (for current discussions refer to Harhoff and Hoisl (2010)). In the context of an ongoing debate on the benefits and drawbacks of the patent system, such a comparison is of crucial importance.

Our study contributes empirical evidence to this discussion. We provide a comprehensive analysis of patent filing motives of various types of patent applicants. Our study's focus is on patent applicants that are "small" regarding their number of filed patent applications (compared to large firms). Specifically, we analyze patenting motives of individual inventors, small firms, and universities and compare them with patenting motives of larger firms.

Such research is highly relevant. For example, only little knowledge exists about patenting behavior of individual inventors. Yet, individual inventors who later found new companies are an important driver of economic growth. Deeper insights into how potential founders and start-ups could benefit from the patent system would provide an important guideline for policy measures that aim at improving conditions for entrepreneurs.

In the same vein, patenting behavior of universities and research institutions merits further attention. Patents are an important facilitator of technology transfer from universities to the private sector. Thus, it is necessary to have a deep understanding of how universities currently use the patent system to ensure that academic research can be effectively turned into economic growth.

Using a sample of 637 randomly chosen patent applicants at the European Patent Office (EPO) we apply ordered probit regression and explorative factor analysis. Our results suggest significant differences between the patenting motives of above applicant types.

For small companies, the signaling effect of patents turns out to be of high importance as a means to convince investors of the value of their business. Universities and individual inventors both prefer patenting over keeping their inventions secret and attach significantly higher importance to the generation of licensing opportunities. An important difference is that

while universities do significantly *not* file patents in order to block others individual inventors attribute most importance of all groups to that motive. We interpret this finding as a higher willingness of universities to license out technology. Thus, university patenting could be interpreted as beneficial to markets for technology. Individual inventors, in turn, focus on licensing and blocking at the same time. This could be interpreted as patent troll-like behavior which aims more at extracting ex post licensing fees (after patent infringement by third parties has already occurred) than on contribution to markets for technology. Small companies, however, might benefit from an ease of firms' access to the patent system in order to improve their access to financial resources.

2. Background: Motives to file patent applications

Scholars have identified various motives to file patent applications (e.g. prevention of imitation, signaling, securing the freedom to operate, generating licensing opportunities and blocking as the most important patenting motives (Burr et al. 2007; Blind et al. 2006; Cohen et al. 2000; Sichelman and Graham forthcoming; Graham et al. 2008).

One of the most prevalent motives to file a patent is the *prevention of imitation* of the underlying invention (Shane 2001).[1] This is also the reasoning for the existence of the patent system which rewards an inventor for publishing the invention with the legal right to exclude others from using it (Arrow 1962; Landes and Posner 2003; Nordhaus 1992; Schlicher 2003; Shane 2001; Teece 1986; Eaton and Kortum 1999; Mansfield et al. 1981).

Another important motive to file for a patent is using the patent as a *signal* to investors, potential partner, and customers. Since patents (can) contain technical information about an invention, they transmit important information. First, they inform about the technological quality and the inventive step of the invention (Blind et al. 2006). Second, the patent shows that the invention is "new", i.e. not yet state of the art (Art. 54-56 The European Patent Convention, 2007) and, third, that "supernormal profits" (Sichelman and Graham forthcoming) might be possible since the patent as an exclusion right offers the theoretical possibility to build an economic monopoly. Finally, patents can be found in patent databases, which are often used by companies and investors in their screening process for technological trends and opportunities. Thus, patenting increases a young firm's visibility to potential investors, cooperation partners, or customers (Christensen 2008; Gick 2008; Arundel 2001;

[1] Apart from protection of imitation by patenting, other means to protect innovations exist. Among them are secrecy, trademarks, complementary assets, lead time or product complexity (Teece 1986; Cohen et al. 2000).

Graham et al. 2008; Mann 2005; Long 2002; Graham et al. 2008; Lemley and Shapiro 2005; Gallini Spring, 1992).

Another motive to file a patent can be to secure one's own *freedom to operate* (Blind et al. 2006; Henkel and Pangerl 2008).[2] Freedom to operate is defined as the "right to practice the invention in the first place" (Henkel and Jell 2009; also: Baker and Mezzetti 2005). Patent applications are published 18 months after the filing day. The publication turns the underlying invention into prior art and prohibits any third party form patenting the same invention (independent of whether or not the patent will be granted later). Scholars found that firms systematically file such preemptive patent applications in order to reduce the risk of being excluded by third parties from using their own inventions (Henkel and Jell 2009; Pangerl 2009, 186; Henkel and Pangerl 2008; de Rassenfosse et al. 2008)

Generating *revenues from licensing* is a further motive for patenting (Cohen et al. 2000; de Rassenfosse et al. 2008; Arora 1997; Hall and Ziedonis 2001; Levin et al. 1987; Duguet and Kabla 1998; Blind et al. 2009)[3]. For example, if one lacks the required resources and complementary assets to manufacture and sell a product based on a new invention, out-licensing can be a profitable option (Teece 1986). Further, licensing is attractive for entities whose "core business" is research and development rather that manufacturing and production, e.g. universities or so-called "fables firms" in the semiconductor industry.

A further motive for a patent application is the *blocking* of competitors. Often, applicants seek patents for technologies that will not be incorporated to their own products or processes. Such patents can be intended to prevent competitors from commercializing substitute products or technologies. This strategy is called patent "fencing".(Cohen et al. 2000; Cohen et al. 2002; Jell and Henkel 2010; Reitzig 2004; Schneider 2008).[4] A very prominent example for a patent fence is the case of Nylon (for more information refer to Hounshell and Smith 1988; Schneider 2008). Further, strategies by so-called patent trolls are based on patenting (or acquiring patents) without manufacturing the underlying invention. The business model of patent trolls (Reitzig et al. 2007) is based on first (covertly) blocking technology for others and later on extracting ex post royalties or damages from firms that unintentionally infringe upon the troll's patents.

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[2] The patent system can be used for defensive publications if the applicant decides to stay only with the publication and does not pursue the patent itself.

[3] e.g.: "IBM has turned intellectual property licensing into a fine art that has generated over $10 billion in the last decade" (Parchomovsky and Wagner 2005).

[4] A more precise definition is given by Granstrand (2000), p 221:"This refers to a situation where a series of patents, ordered in some way, block certain lines or directions of R&D, for example, a range of variants of a chemical sub-process, molecular design, geometric shape, temperature conditions or pressure conditions. Fencing is typically used for a range of possibly quite different technical solutions for achieving a similar functional result."

2. Development of hypotheses: Applicant Types and patenting motives

Within the scope of this paper, we analyze the patenting motivation of different applicant types. We differentiate the applicant types in three major groups: first, companies, second, universities and research institutions (hereafter universities), and, third, individual inventors. The group of companies is split up by size into three subgroups. We use the definition of the European Commission for small, medium, and large enterprises (European Commission 2003) in order to subgroup the companies. For *small companies*, the size is two to 49 employees. *Medium enterprises* with 50 – 249 employees build another subgroup. Companies with 250 or more employees are defined as big companies, according to the definition of the European Commission (European Commission 2003). Finally, we include a group of *individual inventors* who invent and apply for a patent without an organization in the background. That means the size of the "organization" is one employee.[5]

The hypotheses we draw from our literature review are shown in Table 1. Each hypothesis will be further explained in the following paragraphs. However, our study also contributes to other possible relationships on which we do not state further hypotheses.

Table 1 Overview Hypotheses

H1 The **licensing** motive will be important if the patent applicant	**a)** is an individual inventor (Svensson 2002; Teece 1986)	**b)** is a small firm (Sichelman and Graham forthcoming; Teece 1986)	**c)** is a university (Buenstorf 2009; Geuna and Nesta 2006)
H2 The **signaling** motive for patenting will be important if	**a)** the applicant is an individual inventor (Christensen 2008; Gick 2008; Long 2002)	**b)** the company is a small company (Christensen 2008; Gick 2008; Long 2002)	**c)** the organization is a university (von Ledebur 2009; Antonelli 2008)

Individual inventors

Only few theoretical studies exist on the motives of individual inventors to file for a patent. For inventors that are at the same time the patent holders (individual inventors) the only option to finance the commercialization of their invention is often licensing or selling it (Svensson 2002). Consequently, we hypothesize that generating licensing income is an important patenting motive of individual inventors (H1a). Signaling is likely to be important as well (H2a), since, as discussed above, inventors can use patents to increase their visibility and signal quality to potential investors and customers.

[5] Naturally, the separation between the mentioned applicant types is not perfectly accurate. E.g. some university professors might become individual inventors if the respective university decides not to patent an invention. However, this slight limitation in accuracy does not limit our findings regarding small patent applicants in general.

However, other motives such as prevention of imitation or more strategic motives such as blocking of competitors, or preservation of the freedom to operate might also influence the patenting behavior of individual inventors. However, to our knowledge no study has investigated this relation before. Thus, with respect to these patenting motives of individual inventors, our study is somewhat explorative. We will not state further hypotheses.

Small companies

Unlike individual inventors, small firms have been intensively investigated by empirical research. The most prevalent arguments for the patenting by small companies are connected with their (restricted) financial means (i.e: Sichelman and Graham forthcoming; Ho and Wong 2005; Jell et al. forthcoming). The restriction in capital supply has different possible effects on the patenting behavior. First of all, small firms might generally patent less than bigger firms (Harhoff and Hoisl 2010). Especially regarding the motive of prevention of imitation, small companies might shift to more economic alternatives such as lead-time, secrecy or complementary assets (Teece 1986; Sichelman and Graham forthcoming).

However, small firms may also focus on the licensing aspect of patents as they are "generally (...) focused on research and development[,] (…) invent numerous products" (Sichelman and Graham forthcoming) and might not be able to market all of their inventions. Hence, licensing might be an important motivation for small firms to ensure some return for the invested R&D. Consequently, we test hypothesis *H1b: The licensing motive will be important if the patenting company is a small firm.*

Another aspect of the restricted capital of small companies directly leads to the signaling function of patents. In order to get funding for their business, small firms might use patents to emit a trustworthy signal to potential investors or customers (H2b). As already mentioned, patents are a suitable signal to show the quality of an innovation (Blind et al. 2006). While larger and more mature firms can use existing partners, members of the board of directors or even whole patent portfolios as signals (Amit et al. 1990; Ahuja 2000; Deutsch and Ross 2003), small companies normally do not have these possibilities. Hence, patents are a key signal for small firms (Dushnitsky and Shaver 2009). Moreover, small companies might be interested to get into contact with (Corporate) Venture Capitalists in order to ensure the financing of their venture. Hence, to be noticed when (larger) companies are screening for new technical developments in the market (Gick 2008) is especially relevant for small firms. Consequently, patents are a suitable signal in order to transmit technical and trustworthy information. Summing up, "[p]atents (…) signal a firm's technological capabilities and

therefore increase access to resources such as financial capital and alliance partners" (Hayton 2005; also: Arundel 2001; Christensen 2008; Dosi et al. 2006). Schertler (2007) supplies empirical evidence for the correlation between the number of a small firm's patents and the financing by venture capitalists. Hence, patents can be a suitable signal in order to mitigate a principal agent conflict arising from external financing (Lean and Tucker 2001; Arrow 1962; Shane 2002).

Universities

There is evidence that filing for patents at universities is motivated by different factors. Universities often largely depend on public funds (Buenstorf 2009). Reducing this dependency can be lifesaving if the public funds are cut down. Consequently, von Ledebur (2009) and Antonelli (2008) conduct that universities may use their patents as a form of a reliable signal for the degree of application-orientation of their research. Assuming higher interest of industry in applicable research, universities might obtain higher third-party funds by using patents as signal (H2c).

Another method for reducing the dependency from public funds is to sell the inventions made at a university. The only good "produced" at universities as public institutions is knowledge. Since knowledge can be characterized as a public good (Foray 2004), a tool is necessary to convert it into a tradable good. Patents are a means to convert the produced scientific knowledge into such a good and enable their economic trade on grounds of markets for technology. "Selling" the inventions made at universities would then be licensing the inventions out (or sell the patent) to interested third parties. In a second step, the licensing revenues could be used for financing and would reduce the dependency from public funds (Buenstorf 2009; Geuna and Nesta 2006). Consequently, we hypothesize that universities patent in order to generate licensing income (H1c).

Further patenting motives of universities such as prevention of imitation, blocking of competitors or the maintenance of the freedom to operate are not yet covered by theoretical or empirical studies. As a consequence, we contribute by using an explorative approach to analyze this relationship, and do not work under specific hypotheses.

2. Methods and Data

The empirical findings of this paper are based on the "Applicant Panel Survey 2006 on Future Patent Filings" of the European Patent Office (EPO).[6]

The Applicant Panel Survey is carried out annually with the purpose to gather information about the applicants' intentions regarding future patenting activities. The survey includes a random group and a group of biggest companies especially chosen for the study. However, this paper is based on the randomly chosen applicants to ensure unbiased results. Figure 1 shows the distribution of the different applicant types in our data set.

As stated above, individual inventors, small companies and universities account for almost 30% of the sample. Large companies only work as a reference for our focus types and all results of our ordered probit regressions are estimated against the background of big companies.

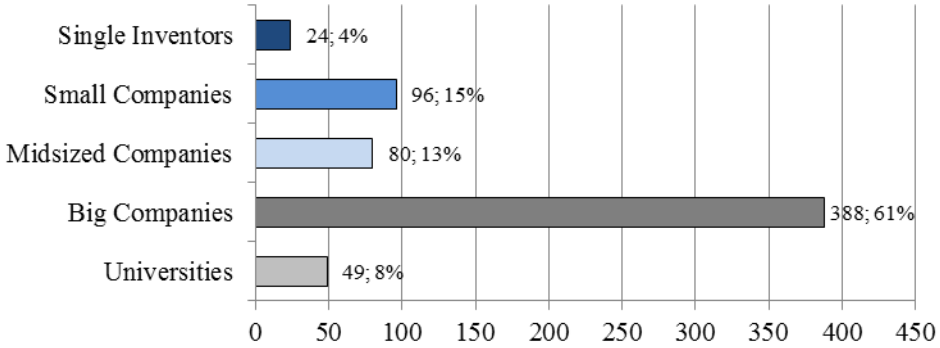

Figure 1: Number of Applicant Types

In order to test the hypotheses constructed in chapter 3 of this paper, an ordered probit model is used since the dependent variables are all of ordinal nature and measure the degree of agreement to the relevance of each motive for patent applications on a five point likert-scale. Each variable is operationalized by a single item of the data set. The importance of the patent filing motive variables (prevent imitation, signaling, freedom to operate, licensing and blocking) are measured on a five point likert scale.

For the different applicant types we take the general differentiation between companies and universities into account. Furthermore, we differentiate between companies and individual inventors on grounds of the number of employees.[7] Regarding the different company sizes, we derive three different company sizes from the variable "number of employees" according

[6] The reason to take data regarding the patent applications instead of granted patents is that we are focusing on the motivation to use the patent system for strategic and non-strategic purposes. With applying for a patent the respective applicant is pursuing already a specific aim. S/he even might not be aiming at a granted patent as in the case of the motive freedom to operate or the patent might not be granted even though the applicant was pursuing the motive prevention of imitation. Whether or not the application will be granted is, hence, of minor importance.

[7] Individual inventors only have one employee.

to the definition of the European Commission for small and medium sized enterprises (European Commission 2003). We control for industry effects by differentiation between complex and discrete sectors. This is done classifying ISIC codes according to Cohen et al. (2000). The differentiation between these sectors is suggested by scholars (Cohen et al. 2000; Hall and Ziedonis 2001) as sectors differ according their patent propensity[8]. Complex sectors are said to be more prone to patenting than discrete sectors (Cohen et al. 2000; Hall and Ziedonis 2001). In order to rule out this effect, we control for the sector type complex versus discrete. Hence, the variable sector_complex is a binary variable (0=discrete; 1= company is active in at least one complex sector). Moreover, we control for country effects including binary variables displaying the country or region an applicant comes from (USA, Japan, Europe, Other). Other control variables are taken directly from the data set. They comprise: usage of an external attorney (dummy); belonging to a company group (dummy); time lag (in month between first R&D expenditures and patenting); number of fulltime researchers; number of inventions 2005, number of sectors the company is active in, total number of patents. Table 2 provides an overview on the used dependent and independent variables.

Table 2: Overview Variables

Dependent Variables	**Measurement**	**Min**	**Max**	**Mean**	**S.D.**
Prevent imitation	Five point likert scale	1	6	4.5767	1.4843
Signaling	Five point likert scale	1	6	2.8939	1.6273
Freedom to operate	Five point likert scale	1	6	4.1945	1.5460
Licensing	Five point likert scale	1	6	3.2779	1.6553
Blocking	Five point likert scale	1	6	4.1803	1.5853
Independent Variables					
Individual inventors	Dummy	0	1	0.0377	0.1906
Small Companies	Dummy	0	1	0.1507	0.3581
Midsized Companies	Dummy	0	1	0.1256	0.3317
Universities	Dummy	0	1	0.0769	0.2667
Control Variables					
Sector Complex	Dummy	0	1	0.7005	0.4584
Europe	Dummy	0	1	0.5755	0.4947
Japan	Dummy	0	1	0.1539	0.3611
USA	Dummy	0	1	0.1978	0.3987
Ext Attorney	Dummy	0	1	0.125	0.3310
Company Group	Dummy	0	1	0.4536	0.4983
Time Lag	Integer	1	39951	2623.231	9878.588
Fulltime Researchers	Integer	0	39937	1073.823	4652.603
No. Inventions 2005	Integer	0	39950	564.8989	3532.116
No. Sectors Active	Integer	0	15	1.864	1.7691
Total No. of Patents	Integer	0	5750	155.1169	508.629

[8] i.e. the number of patents filed in that sector (Graevenitz et al. 2009)

2.1. Descriptive Analyses

Figure 2 gives first insights into the patenting motivation of the different applicant types. Obviously, the traditional patenting motive, prevention of imitation, still is the most important motive for most applicant types. Only universities rate this motive as less important: only every fifth university evaluates prevention of imitation as important or very important. The motive signaling seems to be important especially for small firms and universities likewise: about half of both applicant types rate this motive as important. The motive licensing loses importance as the company size increases, however, 9 out of 10 universities state licensing to be of high importance. The motives freedom to operate and blocking competitors do not provide a clear picture except the last one in case of universities who find blocking of less importance.

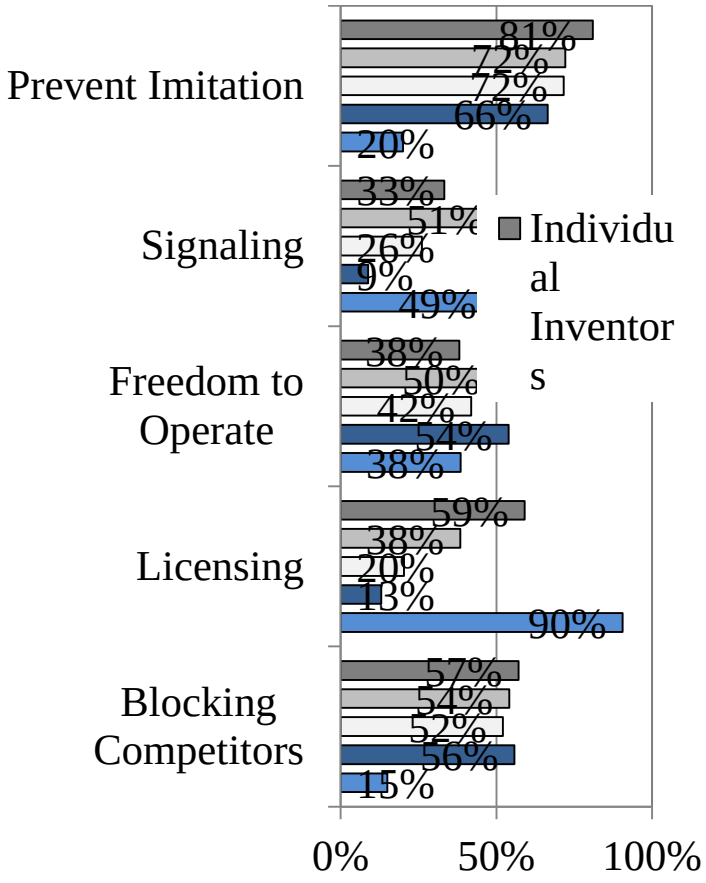

Figure 2: Importance of Motives in %[9]

It is also worthwhile to take a look at single important motives which do *not* come along with other motives of high importance. Figure 3 shows the distribution of applicant types who rate one single motive as important while rating *all* other motives of less importance.[10]

[9] Percentage of each applicant type rating the motive with 5 or 6 on the 6 points Lickert-scale.
[10] Less importance is defined as 1-4 on the Lickert-scale.

The most striking result is provided for universities regarding the licensing motive. Almost one out of three universities rates licensing as the sole important motive to apply for a patent, while rating all other motives as less important. Regarding the protection of imitation motive, about 15% of individual inventors rate this motive of sole importance, as well as 11% of the midsized and 9% of the big companies. Interestingly, only about six out of one hundred small companies do likewise.

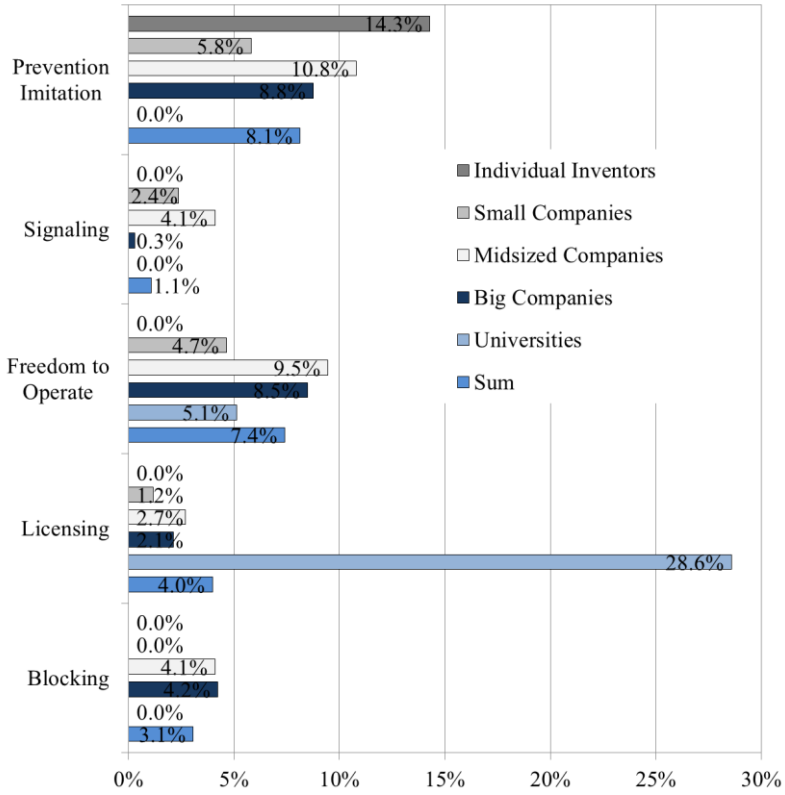

Figure 3: Motives of Sole Importance in %

Freedom to operate (FTO) also receives ratings of sole importance among all applicant types except for individual inventors. Big and midsized companies tend more to rate this motive of sole importance (each about 9-10%) in comparison to universities and small firms (each about 5%). Blocking competitors only gets sole importance ratings among big and midsized companies (around 4% each).

The most interesting information provided by Figure 3 is, however, that in only 24% of all cases, one motive is rated as the sole important motive that drives the patent application. That means around three quarters of all applicants are driven by more than one motive when they decide for a patent application. In order to analyze which motives may usually come together as a kind of motive-bundle, we use the factor analysis (compare chapter 3.2) to get insights into the patent motivation of these applicants.

3. Multivariate Results

Each ordered probit estimation includes the applicant types as independent variables, the countries, the sector type and some further control variables.[11] An overview for all variables is provided in Table 2.

3.1. Ordered Probit Estimations

Table 3 shows the probit estimations for all patenting motives. Starting off with the first motive, two applicant types reveal to have a significant influence in the estimation. Coefficients of "individual inventors" and "universities" are both significant at the 5% level. However, the individual inventors' influence is positive and the universities' is negative. Hence, the individual inventors' propensity to patent is motivated to a large extend by pursuing a protection of imitation of the invention and hypothesis 3a proven.

Table 3: Ordered Probit Estimation

	Prevent Imitation		Signaling		FTO		Licensing		Blocking	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Single Inventors	0.963**	0.391	0.931**	0.355	0.010	0.351	1.872***	0.388	0.334	0.355
Small Companies	0.214	0.221	1.014***	0.222	0.348	0.216	1.008***	0.220	0.246	0.216
Midsized Companies	0.118	0.201	0.339*	0.198	0.097	0.196	0.300	0.195	-0.141	0.196
Universities	-1.251**	0.415	0.182	0.394	-0.276	0.394	1.568***	0.459	-1.059**	0.405
Sector Complex	-0.051	0.151	-0.134	0.147	0.046	0.147	-0.185	0.148	-0.015	0.148
Europe	-0.165	0.282	-0.068	0.272	-0.531*	0.277	-0.193	0.276	0.374	0.276
Japan	0.345	0.356	0.123	0.340	0.252	0.348	-0.009	0.342	0.276	0.343
USA	-0.017	0.319	0.123	0.309	-0.155	0.312	0.218	0.314	-0.305	0.312
Ext Attorney	0.160	0.262	0.113	0.257	0.495*	0.258	0.332	0.253	0.001	0.257
Company Group	-0.382**	0.161	0.298*	0.159	-0.319**	0.158	-0.118	0.157	-0.428**	0.158
Time Lag	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fulltime Researchers	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. Inventions 2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. Sectors Active	0.102	0.066	0.101*	0.060	0.038	0.060	0.200**	0.075	0.088	0.059
Total No. Patents	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo R^2	0.1253		0.2171		0.1086		0.2934		0.1476	
N	252		249		250		252		251	

Significance level: * < 10%, ** < 5%, *** < 1%.

Contrasting, this motive is not relevant for universities as indicated by the negative coefficient. Looking at the corresponding motive of blocking, universities again show a significant coefficient. As the second estimation (Table 6, appendix) shows, the results for

[11] Compare Table 2.

universities are robust for non-US universities.[12] Consequently, taking both motives, prevention of imitation and blocking, into account, we draw our first conclusion that universities do not tend to patent in order to exclude others from the usage of their inventions.

As assumed in our hypothesis 2b, signaling is especially important for small firms. This is confirmed by the results of the ordered probit estimation. Individual inventors are also marked as significant, as assumed in hypothesis H2a, and even midsized companies.[13] Interestingly, this goes hand in hand with the significant coefficients for the licensing motive as far as individual inventors and small companies are concerned. Hence, hypotheses 1a and 1b are confirmed.

Apart from the mentioned applicant types, universities are marked as significant. They are highly motivated by expected future rents from licensing when it comes to patenting their inventions. The results for universities are robust: in the second probit estimation (appendix, chapter 5) both, non-US and US-universities are marked as significant. Consequently, hypothesis 1c is supported by our findings, whereas hypothesis 2c (universities patent for signaling motives) is not.

Regarding the sector type an organization is active in, the ordered probit estimations do not show any significant influences.

3.2. Bundles of motives to patent: Factor Analysis

Our analysis shows that often the coefficient of one applicant type is significantly associated with more than one patent filing motive. We used a factor analysis to test whether certain applicant types a significantly associated with bundles of patenting motives[14] (Spearman 1904; Kim and Mueller 1978b, 1978a).

We included the following variables in the analysis: prevent imitation, signaling, secure freedom to operate, licensing and blocking. In order to test whether the variables have enough in common to justify a factor analysis, we used the Kaiser-Meyer-Olkin measure (KMO) of sampling adequacy (Kaiser 1970, 1974; Kaiser and Rice 1974; Cureton 1983). The test

[12] In order to differentiate between universities from the USA and from other countries, we estimate two probit models one including the general term "Universities" and one the special term "University USA". The reason for us to differentiate between these two groups is to take into account the possibly different patenting cultures. While US universities have been strongly encouraged to patent their inventions for almost 30 years by the Bayh Dole Act, this practice is relatively new in other countries. This difference in the patenting cultures may generally result in a larger patent propensity of US universities and might well enhance their propensity to patent strategically. Our differentiation allows us to investigate whether the results are robust for non-US universities. However, an interpretation of the result for US universities has to be conducted very cautiously due to the small number of entities in the sample. However, we do not expect substantial differences between the two groups of universities as we are analyzing a dataset of patent applications at the EPO. Hence, the patent regime is the same for all applicants regardless of their home country and the grace period does not apply to any of them. Only a certain "patenting culture" originating from the home patent regimes might show some effect on the estimations. The US-universities coefficient is not significant regarding the motive prevention of imitation. Nonetheless, the coefficient still is clearly negative.

[13] The later, however, reveals not to be robust to slight changes in the model (compare Table 6, appendix).

[14] More precisely, we use the principal component factor analysis. This method suits the data the most as the produced uniqueness values are the lowest among all methods. The maximum likelihood factor analysis is not suitable as it produces a Heywood case and this produces one uniqueness of 0. Hence, the test cannot be justified and the maximum likelihood analysis cannot be used (StataCorp LP 2005, 220)

reveals KMO values between 0.48 and 0.71 for the variables and an overall value of 0.55. This indicates "mediocre" to "middling" adequacy (Kaiser 1974, 35; Backhaus et al. 2006, 276). Thus, results from the factor analysis should be interpreted with caution. A popular technique to determine an appropriate number of factors is to take the factors with eigenvalues larger than one (Guttman 1954; Kaiser 1960, 1961; Harman 1976, 198; Bennett and Bowers 1976, 23; Yeomans and Golder 1982). In our case, an optimal number of factors of 2 results (we extracted 5 factors in total: Table 7, appendix).

Table 4 shows the factor loadings after a varimax rotation (Kaiser 1958, 1959). Factor 1 includes patent filing motives related to the exclusion of others, either in order to prevent imitation of own products ("prevent imitation") or to block others from manufacturing certain products (e.g. substitutes) that the applicant does not produce either. Factor 2 includes motives related to technology transfer, namely the usage of patents to become more visible for potential customers, licensees and investors, and, as a next step, using the patent as the legal basis for licensing the invention.

Variable	Exclusion Related Motives	Technology Transfer Related Motives
Prevent Imitation	0.7991	
Signaling		0.8600
FTO		
Licensing		0.7975
Blocking	0.7967	

Table 4: Rotated factor loadings[15]

As a next step, we used factor 1 and factor 2 as dependent variables in an OLS regression model with applicant types as independent variables.

[15] 538 Obs.; rotation: varimax; 49.7 percent of total variance explained; blanks represent factor loadings < 0.4

Table 5: Linear Regression of Factor 1 and Factor 2

	Exclusion Related Motives		Technology Transfer Related Motives	
	Coefficient	S.E.	Coefficient	S.E.
Individual Inventor	0.329	0.292	1.356 ***	0.304
Small Companies	0.202	0.176	1.078 ***	0.182
Midsized Companies	-0.047	0.162	0.323 *	0.169
University	-1.456 ***	0.320	0.793 **	0.333
Sector Complex	0.027	0.122	-0.168	0.127
Ext Attorney	0.102	0.206	0.124	0.214
Company Group	-0.444 **	0.131	0.105	0.136
Time Lag	0.000	0.000	0.000	0.000
Fulltime Researchers	0.000	0.000	0.000	0.000
No. Inventions 2005	0.000	0.000	0.000	0.000
No. Sectors Active	0.071	0.046	0.107 **	0.048
Total No. Patents	0.000	0.000	0.000	0.000
Constant	0.518	0.324	-0.649 *	0.337
Pseudo R^2	0.1662		0.2769	
N	247		247	

Significance level: * < 10%, ** < 5%, *** < 1%.

Our results are most interesting for universities. We find a significant negative coefficient (β = -1.456) of factor 1 (exclusion-related motives) and a positive significant coefficient (β = 0.793) of factor 2 (technology transfer-related motives). This can be interpreted as high willingness of universities to contribute to the functioning of markets for technology, i.e. to be a visible provider of research and technology willing to license the technology out, rather than strategically blocking market participants.

As expected, factor 2 also possesses high coefficients for the variables individual inventors and small firms with significance levels of 1%. Midsized companies also show significant (10% level) coefficient which is comparable low (only 0.323).

Thus, factor 2 somewhat represents patenting motives of smaller patent applicants, which are likely less visible on the market place than large companies, and which might lack resources for manufacturing and selling products based on their inventions. Consequently, these entities use patents more intensively than large firms to transfer their technology.

4. Conclusion

In this paper we analyze the motivation of small applicant types for filing patents. From our analyses we derive, firstly, that the prevention of imitation still is the main motive for most applicant types including the small ones, while universities are the one and only exception. They, in turn, form a special applicant group focusing mainly on patenting on the ground of creating licensing opportunities. Universities share this motive with individual inventors and small companies. Both are motivated by possible licensing opportunities, too. However, they

also take into account the signaling and prevention aspect of patents. Especially small firms heavily rely on the signaling aspect which may offer them financing opportunities for inventions with own production. Contrasting, licensing out their inventions creates financing opportunities without production of the invention in house.

Concluding, universities want to gain license fees from their inventions but refrain from using their patents for blocking someone. This may foster the strength of technology markets and may enhance the speed of diffusion of technology. However, more research on the effectiveness of patenting by universities is still needed. Without assessing the value of the patents contributed by universities, it is hard to say whether supporting or enhancing their patenting activities is beneficial from a welfare perspective. The motivation behind universities' patenting behavior is explained by the results of our models. However, whether the motivation is based on realistic expectations and assumptions of whether or not patents really will fulfill the function universities file them for remains a topic for further research.

Small companies use patents in order to convince investors of an investment and to generate income from licensing. Still, it is not clear whether this motivation is grounded on realistic expectations and is beyond the scope of this article. Moreover, the sample itself suggests that a relatively small number of small firms make use of the opportunities provided by the patent system (compare Figure 1) and the reasons for small companies not to patent remain unclear. This limitation of our study opens a large space for future research. The critical evaluation of small companies' motivation for patenting and the investigation of the decision not to patent are crucial to understand the behavior of small firms and small applicants in general. Whether or not a well-directed support of small firms in the process of patent applications may ease the access to capital from investors or banks is subject to discussion and definitely requires further research.

Contrasting to small companies and universities, individual inventors mainly focus on licensing income possibly generated by their patents. This may, on the one hand, strengthen technology markets similarly to the universities' behavior. However, individual inventors stress the prevention of imitation motivation regarding their patent filings and as indicated by the ordered probit analyses many individual inventors rely on blocking and the prevention of imitation. Taking both motivations into account, this draws the picture of patent trolls who "are patent holding individuals or (often small) firms who trap R&D intensive manufacturers in patent infringement situations in order to receive damage awards for the illegitimate use of their technology" (Reitzig et al. 2007). Whether or not especially individual inventors aim at

trolling strategies is beyond the scope of this paper and remains as a future area of research. One aspect clearly contradicting this possibility is the lack of expertise regarding the legal issues connected with infringement suits, an individual inventor may face. Moreover, one typical aspect of a troll's business model is to buy patents or whole patent portfolios in order to use them for infringement suits and only rarely trolls patent own inventions (e.g. IP-Com against Nokia, who bought the relevant patents from Bosch: Pohlmann and Opitz 2009).

Notwithstanding, individual inventors as future entrepreneurs might also be interested in protecting their IP in order to be able to reap off the rents from their innovation with a suitable business model including a comprehensive IP management strategy. Hence, whether trolling is a real option for individual inventors or whether it plays a minor role in this context is subject to discussion. There are some theoretical and empirical indications for such troll business models. Nonetheless, the concrete strategies of individual inventors merit a deeper analysis.

References

Ahuja, Gautam (2000): The Duality of Collaboration: Inducements and Opportunities in the Formation of Interfirm Linkages, *Strategic Management Journal* 21, 317–343.

Amit, Raphael; **Glosten**, Lawrence; **Muller**, Eitan (1990): Entrepreneurial Ability, Venture Investments, and Risk Sharing, *Management Science* 36, 1232–1245.

Antonelli, C. (2008): The new economics of the university: a knowledge governance approach, *The Journal of Technology Transfer* 33, 1–22.

Arora, Ashish (1997): Patents, licensing, and market structure in the chemical industry, *Research Policy* 26, 391–403.

Arrow, K., 1962): Economic welfare and the allocation of resources for invention, in: Nelson, R. (Hrsg.): *The rate and direction of inventive activity,* New York.

Arundel, Anthony (2001): The Relative Effectiveness of Patents and Secrecy for Appropriation, *Research Policy,* 611–624.

Backhaus, Klaus; **Erichson**, Bernd; **Plinke**, Wulff; **Weiber**, Rolf (2006): *Multivariate Analysemethoden - Eine anwendungsorientierte Einführung,* 11., überarbeitete Auflage, Berlin, Heidelberg.

Baker, S.; **Mezzetti**, C. (2005): Disclosure as a Strategy in the Patent Race, *The Journal of Law and Economics* 48, 173–194.

Bennett, S.; **Bowers**, D. (1976): *An introduction to multivariate techniques for social and behavioural sciences,* New York.

Blind, Knut; **Edler**, Jakob; **Frietsch**, Rainer; **Schmoch**, Ulrich (2006): Motives to patent: Empirical evidence from Germany, *Research Policy* 35, 655–672.

Blind, Knut; **Cremers**, Katrin; **Mueller**, Elisabeth (2009): The influence of strategic patenting on companies' patent portfolios, *Research Policy* 38, 428–436.

Buenstorf, G. (2009): Is commercialization good or bad for science? Individual-level evidence from the Max Planck Society, *Research Policy* 38, 281–292.

Burr, Wolfgang; **Stephan**, Michael; **Soppe**, Birthe; **Weisheit**, Steffen (2007): *Patentmanagement- Strategischer Einsatz und ökonomische Bewertung von technologischen Schutzrechten,* Stuttgart.

Christensen, Jespers (2008): The IPR System, Venture Capital and Capital Markets - Contributions and Distortions of Small Firm Innovation?, **Copenhagen Business School,** DRUID Working Paper No. 08-03.

Cohen, W.; **Nelson**, R.; **Walsh**, J. (2000): Protecting their intellectual assets: appropriability conditions and why US manufacturing firms patent (or not), *Working Paper,* **National Bureau of Economic Research,** SSRN No. 214952.

Cohen, Wesley; **Goto**, Akira; **Nagata**, Akiya; **Nelson**, Richard; **Walsh**, John (2002): R&D spillovers, patents and the incentives to innovate in Japan and the United States, *Research Policy* 31, 1349.

Cureton, Edward (1983): *Factor analysis- An applied approach,* New York.

Deutsch, Yuval; **Ross**, Thomas (2003): You Are Known by the Directors You Keep: Reputable Directors as a Signaling Mechanism for Young Firms, *Management Science* 49, 1003–1017.

Dosi, G.; **Marengo**, L.; **Pasquali**, C. (2006): How much should society fuel the greed of innovators?: On the relations between appropriability, opportunities and rates of innovation- *Special issue commemorating the 20th Anniversary of David Teece's article, "Profiting from Innovation", in Research Policy, Research Policy* 35, 1110–1121.

Duguet, Emmanuel; **Kabla**, Isabelle (1998): Appropriation Strategy and the Motivations to Use the Patent System: An Econometric Analysis at the Firm Level in French Manufacturing, *Annales d'Économie et de Statistique*, 289–327.

Dushnitsky, Gary; **Shaver**, Myles (2009): Limitations to interorganizational knowledge acquisition: the paradox of corporate venture capital, *Strategic Management Journal*, 1045–1064.

Eaton, Jonathan; **Kortum**, Samuel (1999): International technology diffusion: Theory and measurement, *International Economic Review* 40, 537–570.

European Commission (2003): Recommendation 2003/361/EC. http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm. Last checked: 13.04.2010.

European Patent Organisation (2007): The European Patent Convention- *EPC.* http://documents.epo.org/projects/babylon/eponet.nsf/0/E4F8409B2A99862FC125736B00374CEC/$File/EPC_13th_edition.pdf. Last checked: 02.03.2010.

Foray, Dominique (2004): *Economics of knowledge*, Cambridge, Massachusetts.

Gallini, Nancy (Spring, 1992): Patent Policy and Costly Imitation, *The RAND Journal of Economics* 23, 52–63.

Geuna, A.; **Nesta**, L. (2006): University patenting and its effects on academic research: The emerging European evidence, *Research Policy* 35, 790–807.

Gick, Wolfgang (2008): Little Firms and Big Patents: A Model of Small-Firm Patent Signaling, *Journal of Economics and Management Strategy* 17, 913–935.

Graevenitz, G.; **Wagner**, S.; **Harhoff**, D. (2009): How to measure patent thickets–a novel approach, *Working Paper*.

Graham, S.; **Sichelman**, T.; **Hall**, B. (2008): Why Do Start-Ups Patent?, *Berkeley Technology Law Journal* 23, 1063–1097.

Granstrand, Ove (2000): *The economics and management of intellectual property- Towards intellectual capitalism*, Cheltenham.

Guttman, L. (1954): Some necessary conditions for common-factor analysis, *Psychometrika* 19, 149–161.

Hall, Bronwyn; **Ziedonis**, Rosemarie (2001): The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995, *RAND Journal of Economics* 32, 101–128.

Harhoff, Dietmar; **Hoisl**, Kathrin (2010): Patente in mittelständischen Unternehmen - Eine empirische Studie des Instituts für Innovationsforschung, Technologiemanagement und Entrepreneurship, München.

Harman, H. (1976): *Modern factor analysis*, Chicago.

Hayton, J. (2005): Competing in the new economy: the effect of intellectual capital on corporate entrepreneurship in high-technology new ventures, *R&D Management* 35, 137–155.

Henkel, Joachim; **Pangerl**, Stefanie (2008): Defensive Publishing - An Empirical Study, *Working Paper*, **Technische Universität München,** SSRN No. 981444.

Henkel, Joachim; **Jell**, Florian (2009): Alternative Motives to File for Patents: Profiting from Pendency and Publication, *Working Paper*, **Technische Universität München,** SSRN No. 1271242.

Ho, Yuen; **Wong**, Poh (2005): Availability of Financing, Regulatory Business Costs and National Entrepreneurial Propensity, *SSRN eLibrary*.

Hounshell, D.; **Smith**, J. (1988): *Science and corporate strategy: Du Pont R&D, 1902-1980,*

Jell, Florian; **Block**, Jörn; **Henkel**, Joachim (forthcoming): Innovativität als Kriterium bei Venture Capital-Investitionsentscheidungen, Kredit und Kapital, *accepted for publication*.

Jell, Florian; **Henkel**, Joachim (2010): Patent Portfolio Races in Concentrated Markets for Technology, *DRUID Working Paper No. 10-23*.

Kaiser, H. (1958): The varimax criterion for analytic rotation in factor analysis, *Psychometrika* 23, 187–200.

Kaiser, H. (1959): Computer program for varimax rotation in factor analysis, *Educational and psychological measurement* 19, 413.

Kaiser, H. (1960): The application of electronic computers to factor analysis, *Educational and psychological measurement* 20, 141.

Kaiser, H. (1961): A note on Guttman's lower bound for the number of common factors, *British Journal of Statistical Psychology*.

Kaiser, H. (1970): A second generation little jiffy, *Psychometrika* 35, 401–415.

Kaiser, H. (1974): An index of factorial simplicity, *Psychometrika* 39, 31–36.

Kaiser, H.; **Rice**, J. (1974): Little Jiffy, Mark IV, *Journal of Educational and Psychological Measurement* 34, 111–117.

Kim, J.; **Mueller**, C. (1978a): *Introduction to factor analysis: What it is and how to do it,* Newbury Park, CA.

Kim, J.; **Mueller**, C. (1978b): *Factor analysis: Statistical methods and practical issues,* Newbury Park, CA.

Landes, William; **Posner**, Richard (2003): *The economic structure of intellectual property law,* Cambridge, Mass.

Lean, J.; **Tucker**, J. (2001): Information Asymmetry, Small Firm Finance and the Role of Government, *Journal of Finance and Management in Public Services* 1, 43–62.

Ledebur, Sidonia von (2009): Patent Productivity of German Professors over the Life Cycle, *Working Paper*.

Lemley, M.; **Shapiro**, C. (2005): Probabilistic patents, *Journal of Economic Perspectives* 19, 75–98.

Levin, Richard; **Klevorick**, Alvin; **Nelson**, Richard; **Winter**, Sidney (1987): Appropriating the Returns from Industrial Research and Development, *Brookings Papers on Economic Activity*, 783.

Long, Clarisa (2002): Patent Signals, *The University of Chicago Law Review* 69, 625–679.

Mann, Ronald (2005): Do Patents Facilitate Financing in the Software Industry?, *Texas Law Review* 83, 961–1030.

Mansfield, E.; **Schwartz**, M.; **Wagner**, S. (1981): Imitation costs and patents: an empirical study, *The Economic Journal* 91, 907–918.

Nordhaus, W., 1992): Invention, growth, and welfare: A theoretical treatment of technological change, in: Jussawalla, M. (Hrsg.): *The economics of intellectual property in a world without frontiers,* New York.

Pangerl, Stefanie (2009): *Defensive Publishing- Handlungsfreiheit und die Aneignung von Innovationsgewinnen,* 1. Aufl., Wiesbaden.

Parchomovsky, Gideon; **Wagner**, R. (2005): Patent Portfolios, *University of Pennsylvania Law Review* 154, 1–77.

Pohlmann, Tim; **Opitz**, Marieke (2009): The Patent Troll Business: An Efficient Model to Enforce IPR? A Typology of Patent Trolls, Using Empirical Evidence from German Case Studies, *Working Paper*.

Rassenfosse, G. de; **Guellec**, D.; **La Potterie**, B. de (2008): Motivations to Patent: Empirical Evidence from an International Survey, *Working Paper*, **Université Libre de Bruxelles,** ECARES.

Reitzig, Markus (2004): The Private Values of 'Thickets' and 'Fences': Towards an Updated Picture of the Use of Patents across Industries, *Economics of Innovation and New Technology* 13, 457–476.

Reitzig, Markus; **Henkel**, Joachim; **Heath**, Christopher (2007): On sharks, trolls, and their patent prey--Unrealistic damage awards and firms' strategies of "being infringed", *Research Policy* 36, 134–154.

Schertler, Andrea (2007): Knowledge Capital and Venture Capital Investments: New Evidence from European Panel Data, *German Economic Review* 8, 64–88.

Schlicher, John (2003): *Patent law- Legal and economic principles,* 2nd ed., St. Paul Minn.

Schneider, C. (2008): Fences and competition in patent races, *International Journal of Industrial Organization* 26, 1348–1364.

Shane, S. (2001): Technology regimes and new firm formation, *Management Science* 47, 1173–1190.

Shane, S. (2002): Selling university technology: patterns from MIT, *Management Science,* 122–137.

Sichelman, T.; **Graham**, S. (forthcoming): Patenting by Entrepreneurs: an Empirical Study, *Michigan Telecommunications and Technology Law Review*.

Spearman, C. (1904): General Intelligence, Objectively Determined and Measured, *The American Journal of Psychology* 15, 201–292.

StataCorp LP (2005): *Stata multivariate statistics- Reference manual : release 9,* Version 9., College Station, Texas.

Svensson, R. (2002): Commercialization of Swedish patents a pilot study in the medical and hygiene sector, **IUI, The Research Institute of Industrial Economics**.

Teece, David (1986): Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy, *Research Policy* 15, 285–305.

Yeomans, K.; **Golder**, P. (1982): The Guttman-Kaiser criterion as a predictor of the number of common factors, *The Statistician* 31, 221–229.

Appendix

Table 6: Ordered Probit Estimation – Differentiation of US Universities

	Prevent Imitation		Signaling		FTO		Licensing		Blocking	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Single Inventors	0.881 **	0.387	0.912 **	0.351	-0.041	0.346	1.857 ***	0.384	0.287	0.349
Small Companies	0.168	0.212	1.006 ***	0.214	0.355 *	0.208	1.005 ***	0.211	0.175	0.208
Midsized Companies	0.101	0.198	0.286	0.194	0.041	0.192	0.301	0.192	-0.130	0.192
University USA=0	-1.586 **	0.491	0.304	0.456	-0.257	0.455	1.402 **	0.546	-1.120 **	0.465
University USA=1	-0.857	0.619	-0.206	0.628	-0.622	0.617	1.893 **	0.725	-1.056 *	0.630
Sector Complex	-0.043	0.151	-0.144	0.147	0.031	0.146	-0.199	0.147	0.023	0.147
Ext Attorney	0.037	0.255	0.045	0.249	0.274	0.251	0.234	0.246	0.118	0.250
Company Group	-0.348 **	0.159	0.293 *	0.157	-0.290 *	0.155	-0.059	0.155	-0.469 **	0.156
Time Lag	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fulltime Researchers	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. Inventions 2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. Sectors Active	0.124 *	0.068	0.094	0.060	0.042	0.058	0.210 **	0.078	0.096	0.060
Total No. Patents	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo R^2	0.1095		0.2118		0.0542		0.2813		0.0980	
N	253		250		251		253		252	

Significance level: * < 10%, ** < 5%, *** < 1%.

Table 7: Factors Extracted From Variables of Patenting Motives

Variable	Eigenvalue	Difference	Proportion	Cumulative explained variance
Factor 1	1.61322	0.33297	0.3226	0.3226
Factor 2	1.28025	0.32107	0.2560	0.5787
Factor 3	0.95918	0.35980	0.1918	0.7705
Factor 4	0.59939	0.05142	0.1199	0.8904
Factor 5	0.55	.	0.11	1