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Human Capital in Outsourcing Decisions

An Empirical Study on Patent Data

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Abstract

Outsourcing of knowledge activities has become more popular as the world's economy has become increasingly knowledge-based in recent years (Parkhe, 2007). The knowledge that is held by a firm is known as the firm's Human Capital, which is considered the most important intangible resource within a firm (Musteen & Ahsan, 2013). Further, researchers have found that there is a relation between the level of human capital within a firm and the likelihood of outsourcing knowledge-based processes (Mayer, Somaya, & Williamson, 2012).

The purpose of this study is to update and extend previous research by Mayer et al. (2012) on the relation between human capital and outsourcing in knowledge-based processes, and to reinforce its implications.

Based on US patent data from 2005 to 2015, we analyse 113 Fortune 500 firms and their decisions to outsource the patent application process. We first identify the outsourced patents based on a series of assumptions and controls. We propose that the decision to outsource a patent application process is driven by the specific human capital in the firm, or the lack thereof. We estimate the degree of accumulated human capital in the firm at the time of the application drafting and analyse its effect on the outsourcing decision.

Our results support previous research on this topic. We find that relevant firm-specific and industry-specific human capital in the firm decreases the probability of outsourcing, while the degree to which the patent application process requires occupational human capital increases this probability. We also find that the internal capacity of the firms' legal departments is negatively related to outsourcing of the patent application process.

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1. Introduction

A common challenge in organizational theory is the organization of the firm's value chain. Firms must decide whether an activity should be outsourced, which suppliers to potentially engage and how to structure the supplier-relationship. Balancing the outsourcing trade-offs of different activities can be challenging, but increased competition and the need for cost efficient production forces more firms to engage in outsourcing.

The economy in developed countries is increasingly becoming more knowledge- and service based (Parkhe, 2007). These service areas have contributed to an increasing share of the countries' total value creation over the recent years (Mayer et al., 2012). The implications of this on corporate strategy and organizational structures are large (Parkhe, 2007), and the emergence of knowledge-based firms has led to an increased demand in knowledge-based services (Edvardsson & Oskarsson, 2011). To our knowledge, few empirical studies have been conducted on outsourcing of knowledge-based services. However, interesting findings have been done within the patenting field, both in terms of drivers of outsourcing in patenting processes (Mayer et al., 2012), and the effects that outsourcing of this knowledge work may have on other processes in the vertical chain (Reitzig & Wagner, 2010).

The patent application process, meaning the drafting and filing of the patent application, is in many cases a comprehensive process. This means that it requires varying degrees of expertise, depending on the nature of the invention or other firm related and industry related aspects. Thus, some firms will choose to outsource their patent application processes to highly specialized law firms, while others will choose to process these applications internally, often through their own in-house law departments. Even more interesting, some firms will choose to outsource the occasional patent application process, while leaving others to be processed internally. This presents the question of what drives the outsourcing decision, besides the classic factors of economic resources, capacity and withholding sensitive information.

Mayer et al. (2012) found that outsourcing of the patent application process is related to the accumulated levels of specific types of human capital in the firm. Characteristics of the invention to be patented indicate the kind of knowledge that is relevant to the patenting process. Further, as firms process different patent applications requiring specific knowledge, this knowledge is accumulated in the firm as human capital. The amount of accumulated

human capital will be relevant in subsequent patent application processes, and influence the outsourcing decision as the firm's increased experience makes them more equipped.

This study aims to update previous findings on the role of specific human capital in the patent application process. Based on the study by Mayer et al. (2012), and the increasing position of outsourcing in knowledge-based services, we seek to confirm the relevance of this research and its implications.

1.1 Research Question

We present the following research question:

In what way does human capital and internal capacity affect the firm's decision to outsource a patent application process?

The purpose of this study is to understand how human capital affects the outsourcing decision related to the patent application process. In addition, we propose a second element to our research question, examining the effect of in-house legal staff capacity on the outsourcing decision. Our contribution is thus an update and potential reinforcement of previous empirical evidence on the effect of human capital, by employing a more recent timeframe. As times progresses and the trends in innovation characteristics change, we aim to confirm the continuing relevance of this research. Secondly, we add the element of internal capacity to the analysis. The recent timeframe and the added element of internal capacity both contribute to increased robustness of the findings within this field.

In the next section, we will elaborate on patenting and the patent application process specifically, before we present the theoretical framework of outsourcing and human capital, and how this relates to the patent application process. In section 3 we present our model and hypotheses, while section 4 explains our research design. Section 5 presents our data collection, analysis and results, as well as the limitations and weaknesses in this study. Finally, in section 6 we discuss the implications of our results.

2. Theoretical Background

2.1 Patents

A patent is defined as a grant of property right to the inventor, meaning the right to exclude others from making, using, offering for sale or selling an invention (USPTO, 2011). Although firms today use other mechanisms to protect their ideas, for example secrecy, patenting is still an important part of many firms' R&D-strategy. Without the opportunity to patent, many firms would be reluctant to invest in R&D because of the risk of their competitors copying their innovations and destroying their chances of economic gains from their investments. The duration of a patent protection is normally 20 years (in the United States) from the date that the application for the patent was filed. This enables firms to invest in R&D knowing that they are guaranteed sufficient time to develop their innovations into profitable products and technologies.

629 647 patent applications were filed in the US in 2015 (United States Patent and Trademark Office, 2016), which is a 2 % increase from 2014, showing a strong growth in the demand for intellectual property rights (WIPO Statistics Database, 2017). The number of patents granted was 325 979, of which 0,2 % were reissues of prior patents. The US accounted for 20,4 % of patent filings, only surpassed by China which accounted for 38,1 % and had 1,1 million applications for utility patents. Along with Japan, South-Korea and The European Patent Organization the five offices account for four-fifths of all patent filings worldwide. Computer technologies is the number one technology field in the US and accounted for 12,3 % of US filings in 2016. Qualcomm Incorporated is the largest patent filer in the US, and the third largest globally, only surpassed by China's ZTE Corporation and Huawei Technologies. Other large patent filers in the US include Hewlett-Packard and Intel Corporation.

To obtain patent protection, the inventor or assignee must file an application. The patent application filing process is a comprehensive process that can be time-consuming and requires different levels and types of knowledge. When filing for a patent, the applicant must disclose all relevant prior art (Steensma, Chari, & Heidl, 2015). This means listing all former patents and literature that the innovation builds upon. The patent must also include an overview of what exactly the applicant claims to have invented and be named the rightful owner of. One patent usually lists several different "claims" to specify the innovative aspect of the new

product or technology. In some cases, the patent application might not be too comprehensive, but more complicated technologies in more competitive areas will require a more detailed application. After the patent has been filed, an examiner of the USPTO will investigate both the prior art disclosed and the claims listed, to ensure that all relevant prior art is listed and that the innovation is in fact new and does not infringe on previously patented property. The examiner might both add and remove prior art listed on the patent if he or her does not consider it to be accurate. Patents are only granted if the claims are considered valid. The validation of the patent is a negotiation between the applicant and the examiner. If the application does not fulfil the requirements, the applicant will have the opportunity to make the necessary changes within a certain time. After the application has been approved, it is the assignee's own responsibility to uphold the patent protection by identifying potential threats and infringements.

Because the patent application process varies in comprehensiveness, the level of skills and knowledge required in the process will also differ. It is possible for an inventor to file a patent application without the help of a patent attorney or patent agent. However, this might be disadvantageous if the inventor is facing a comprehensive application, as the risk of obtaining a flawed patent or having the application rejected may be higher without the help of a specialist. Patent attorneys and patent agents are highly specialized professionals with technical backgrounds (Mayer et al., 2012). Only registered patent attorneys and patent agents who have passed the USPTO registration examination, may practice before the USPTO. A patent attorney or patent agent may be employed by the firm filing for the patent, usually within a legal department, or by an external professional law firm. Whether to use an internal or external patent attorney is a choice not only varying between firms but also between patents within the firm. It is seemingly a complicated decision, as are outsourcing decisions in general.

2.2 Outsourcing

Many firms choose to outsource activities to external suppliers to be more efficient and achieve cost savings. Outsourcing can be defined as “allocating or reallocating a firm's internal activities and services to outside providers” (Edvardsson & Oskarsson, 2011). These are activities that could have been produced internally, but are sourced to external suppliers, called “market firms” (Besanko, Drandove, Shanley, & Schaefer, 2010). A firm's decision to organize activities internally or to purchase them from an external firm is called a “make-or-

buy”-problem. “Make” refers to performing an activity internally, and “buy” refers to purchasing the service from an external supplier. Understanding how firms shape their boundaries, as well as understanding the incentives for outsourcing production and other activities, has interested management scholars for years. The most dominant goal cited for outsourcing is cost savings (Holcomb & Hitt, 2007). However, there are also several strategic aspects that should be considered. There is widespread agreement that in a perfect market, firms should focus their activities on core competencies and leave the rest of their production to external suppliers (Quinn, 1999). A firm’s core competencies are the few activities the firm does best, relative to their competitors. Quinn (1999) describes core competencies as the few activities the firms can develop to be “best-in-world”-capabilities. To understand firms’ sourcing decisions, we must consider both economic as well as strategic benefits and risks.

2.2.1 Strategic Benefits

Sourcing activities to external specialists provides the buyer firms with more flexibility of the production in their value chain (Quinn & Hilmer, 1994), and allows them to strategically focus on their core competencies. This enables them to focus on their internal resources and invest in new technologies and developments in what they do best. Consequently, a strategic focus on core competencies enables buyers to make entrance barriers for competitors. Additionally, in fast developing markets or in industries with rapid change, buyer firms might enjoy great benefits from purchasing activities. This because supplier firms may possess greater capabilities and knowledge, and consequently be more responsive to changes than buyer firms. With a high level of knowledge generated in the firm, suppliers will also be able to offer higher quality services. In this way, buyer firms can utilize supplier firms’ investments, innovation strategies, capabilities and knowledge, that otherwise would have been expensive or impossible to duplicate. Thus, outsourcing activities will decrease buyer firms’ risks, reduce their investments and create better responsiveness to customers.

2.2.2 Economic Benefits

There are several economic benefits of outsourcing. Supplier firms may possess knowledge or patents that enables them to produce at a lower cost (Besanko et al., 2010). Secondly, supplier firms might aggregate the demand of many customers within a specific industry and enjoy economies of scale, while buyer firms only produce for their own needs. Buyer firms will consequently be at a severe cost disadvantage compared to supplier firms. By outsourcing

activities, firms also reduce bureaucracy effects by avoiding potential agency and influence costs.

2.2.3 Strategic Risks

Despite the advantages linked to outsourcing, there are also several risks that might favour internal production. By sourcing activities, buyers might lose critical skills that are crucial to their value chain (Quinn & Hilmer, 1994). This can occur when buyer firms need to re-enter production of activities that were formerly outsourced, or in production of complementary activities. Another risk is the loss of cross-functional skills. These are skills that are generated across functions as a result of interactions among skilled people within a firm. By sourcing the production to external suppliers, this interaction and the knowledge base generated within the firm may be lost. However, if the firm ensures close cooperation with the supplier firm, the generation of cross-functional skills might increase, and the benefits will consequently be even greater. Thirdly, there are risks due to lack of supplier control. This can occur when the priorities of the buyer and the supplier do not match. Hence, it is crucial to have both close contact with the supplier's top management and to have *complete contracts*. A contract is considered to be complete when it eliminates opportunistic behaviour and forces the parties to match their responsibilities (Besanko et al., 2010). However, drafting a complete contract is challenging because of difficulties specifying or measuring performance etc. This makes it difficult to find the correct price for the service. Incomplete contracts can also lead to holdup problems, which happens when a firm tries to renegotiate the terms of a deal after investments in relationship-specific assets have been made. Lastly, sourcing of activities to external suppliers might increase the risk of leakage of sensitive information. When firms use the market to obtain supplies, they might lose control of proprietary technologies.

2.2.4 Economic Risks

When making sourcing decisions, firms should consider both internal and external transaction costs (Quinn & Hilmer, 1994). Purchasing services from supplier firms involves transaction costs and this can be expensive. To justify the external transaction cost, the firm must acknowledge the value of the supplied product or external expertise (Quinn, 1999). On the other hand, when choosing to produce internally, firms often do not include internal transaction costs in their analysis (Quinn & Hilmer, 1994). For example, firms must consider long term transactional costs such as R&D and personnel development. These are costs that

are crucial in the long-term to be competitive.

2.2.5 Transaction-Based and Resource-Based View of Outsourcing

With the article “The Nature of the Firm”, Coase (1937) introduced classic Transaction Cost Economics (TCE) which became a leading outsourcing theory. TCE focuses on firms’ boundary choices being driven largely by the specificity of assets involved in the sourcing decision, and examines individual transactions (Reitzig & Wagner, 2010). This entails focus on outsourcing of specialized, repetitive activities such as manufacturing. However, in later years, TCE has been criticized for excluding considerations that involve knowledge-related interdependencies between different transactions. Although many outsourcing decisions are based on transaction measures, outsourcing may also be a result of *strategic* considerations. Strategic outsourcing is defined as “the organizing arrangement that emerges when firms rely on intermediate markets to provide specialized capabilities that supplement existing capabilities deployed along a firm’s value chain” (Holcomb & Hitt, 2007). A critical theory to TCE, the Resource-Based View (RBV) argues that advantages firms gain by using external suppliers must also be considered against strategic factors, such as development of firm-specific knowledge (Reitzig & Wagner, 2010). In other words, RBV focuses on knowledge and capabilities that are required to benefit from a transaction rather than focusing on the transaction itself. Holcomb and Hitt (2007) explains how RBV is helpful to understand strategic outsourcing in which firms rely on external suppliers in their vertical chain.

2.2.6 The Resource-Based View

RBV focuses on special capabilities and knowledge that exists in intermediate markets (Holcomb & Hitt, 2007). The RBV approach establishes linkages for exchange of capabilities and knowledge in these intermediate markets. Holcomb and Hitt (2007) describe four resource-based arguments for strategic outsourcing; capability complementarity, strategic relatedness, relational capability-building mechanisms and cooperative experience.

Complementarity of capabilities is the degree to which outsourcing can add capabilities that will strengthen the firm’s value chain. Firms seek to obtain such capabilities from external suppliers as it may enhance their performance (Holcomb & Hitt, 2007). When complementary capabilities are linked in an exchange, these capabilities can be difficult for competitors to imitate (Holcomb & Hitt, 2007). Access to complementarity of capabilities will therefore increase the firms’ incentives to outsource their production.

Strategic relatedness characterizes the degree of strategic similarity of firms (Holcomb & Hitt, 2007). Firms who produce and utilize similar goods and services, or rely on similar technologies are likely to have higher degrees of strategic relatedness. Strategic relatedness is important for firm's outsourcing decision because a high degree of relatedness between a firm and their exchange partners implies that they share common goals and can transfer knowledge between them more efficiently. A high degree of strategic relatedness among firms will hence increase the probability of outsourcing.

Relational capability-building mechanisms refers to routines that allow firms to create and leverage specialized capabilities and knowledge (Holcomb & Hitt, 2007). This explains a firm's development of the capability to manage and link capabilities across a value chain. These mechanisms are developed over time, and improve a firm's ability to accumulate, integrate and leverage specialized capabilities. When a firm has developed Relational capability-building mechanism, this may reduce coordination costs and improve the benefits of synergies from outsourcing, increasing outsourcing incentives.

Cooperative experience refers to the benefits of repeated cooperation with specialized firms from intermediate markets (Holcomb & Hitt, 2007). When firms develop patterns of relationships with suppliers, they access information about the reliability and performance of potential partners. Cooperative experience will reduce information asymmetry and opportunistic behaviour, as well as create awareness about specialized capabilities and form a basis of trust. The information exchange and sharing of capabilities between the firm and the supplier may stimulate growth and present more market opportunities for both firms. Thus, cooperative experience increases the probability of future outsourcing to these suppliers.

As described, the outsourcing decision is not just a matter of improving efficiency and cutting costs. Many of the arguments are in fact strategic. In the following we relate the strategic arguments of outsourcing to theory of a resource especially important in knowledge work; the human capital of the firm.

2.3 Human Capital

Human capital can be defined as "any stock of knowledge or characteristics the worker has (either innate or acquired) that contributes to his or her "productivity"" (Acemoglu & Autor, 2011). It is a dimension of what is known as intellectual capital, along with the other

dimensions; social capital and organizational capital (Musteen & Ahsan, 2013). The intellectual capital of the firm is considered the most important intangible resource within a firm. In developed countries today, an increasing amount of processes are knowledge based, and the knowledge a firm holds through its employees is naturally gaining importance.

Knowledge-intensive processes often require specialized human capital, and acquiring this can be demanding. Employing specialists within a field is not only costly in terms of high salaries, but ordinary firms also struggle to offer certain benefits which the potential employees might obtain by choosing employment at a more specialized firm within their field of expertise (Mayer et al., 2012). The potential for individual development and gaining knowledge that is transferable across industries and firms, is an attractive advantage of working in firm of expertise. For some non-specialist firms this causes a deficiency of certain types of human capital.

Musteen and Ahsan (2013) argue that younger firms use offshoring of knowledge processes as a way to overcome human capital deficiencies, as smaller firms are rarely in a position to employ specialists in their own country. By offshoring knowledge intensive work, they manage to get the expert knowledge they need at a much lower price, taking advantage of external providers' resources and investments in line with classic outsourcing theory.

Mayer et al. (2012) argue that it is exactly the need for specific types of human capital that drives the sourcing decisions in knowledge work, and in patent application processes particularly. Each patent application requires a different combination of competencies depending on the characteristics of the invention. Each firm will hold different levels of the competencies required, depending on their employees and their previous experiences, and this amounts to certain types of human capital in the firm. To structure their argument, they divide the human capital concept into three dimension; *firm-specific human capital*, *industry-specific human capital* and *general human capital*, within the latter they focus on *occupational human capital*. This is an extension of the human capital classification by Castanias and Helfat (1991).

2.3.1 Firm-Specific Human Capital

Firm-specific human capital refers to knowledge about the firm itself, its processes and structures. This is knowledge that is unique to each firm, and includes a deeper knowledge of

the firm's history, culture, strengths and weaknesses (Castanias & Helfat, 1991). This knowledge is difficult to obtain for someone outside the firm, because it not only includes knowledge of different aspects within the firm, but also the nature of how these aspects work together. For example, an internal attorney in a firm would typically have knowledge of the firm's R&D processes, competition and strategies, resources available and specific knowledge of current and prior products. These skills taken alone may not be considered firm-specific, it is however the combination of these skills, that is likely to be unique to the firm (Lazear, 2009).

Mayer et al. (2012) argue that the more important firm-specific knowledge is considered to a process, the less likely it is that the firm will outsource this process to an external provider, given that the firm holds this firm-specific knowledge. Not all firm-specific knowledge will be relevant in every process, and it is important to understand what firm-specific knowledge is relevant, and to which degree this has been accumulated in the firm. If a process requires relevant firm-specific human capital, the firm will be less likely to outsource the process the more relevant firm-specific human capital the firm has accumulated.

External producers face a disadvantage when it comes to firm-specific knowledge, seeing as they are not likely to possess this knowledge about their clients. In some cases, however, external providers may have produced related products for competitors with similar structure and processes. In this way an external provider might possess a sufficient level of firm-specific human capital (Mayer et al., 2012). Even though it is unlikely that the level will exceed the one of the firm itself, this may also influence a potential outsourcing decision.

2.3.2 Industry-Specific Human Capital

Industry-specific human capital is a type of human capital that refers to capabilities that are particularly relevant to specific types of firms or industries. This might be knowledge about the industry setting or domain, and thus it is transferable across the set of firms in the same industry, or with projects within the same industry domain (Castanias & Helfat, 1991).

As with firm-specific human capital, when a process requires industry-specific human capital, the firm is less likely to outsource the process the greater the accumulated levels of relevant industry-specific human capital is within the firm (Mayer et al., 2012). The more relevant knowledge the firm has about the industry, the more likely it is that the process will be kept

internal. When a firm produces something within the boundaries of the industry or technology area where it holds most of its experience, it is likely to keep the production internal. On the other hand, if a firm decides to produce something within an industry which is relatively new to the firm, or considered to be an industry in which the firm does not usually operate, they may lack the industry-specific knowledge that is relevant for the process. In this case, the firm must make a decision of high strategic importance. The firm may either use external suppliers to access the knowledge required, or it may keep the production internal, to gain the industry-specific knowledge required through “learning by doing”. If the firm chooses to outsource the production, it is likely that future related processes will also be outsourced, and vice versa. This is because the accumulation of human capital in the firm is the grounds for the decision, creating a cycle in the decision making.

Researchers argue that it is not a trade-off between accumulation and accessing external expertise, as firms will develop their industry-specific human capital by working closely with external producers in their vertical chain (Parmigiani & Mitchell, 2009; Rothaermel, Hitt, & Jobe, 2006). There are however factors that may limit the effectiveness of this strategy (Mayer et al., 2012). Suppliers will tend to keep information to themselves to prevent clients from “stealing” their knowledge, only to terminate the relation once they can provide the good or service themselves. Industry-specific knowledge is also harder to transfer across firm boundaries than within them, and changing markets may cause the firms to constantly be playing catch-up, making the development of their industry-specific human capital inefficient.

2.3.3 Occupational Human Capital

Occupational human capital is a category within the general human capital definition. General human capital is transferable across industries and firms (Castanias & Helfat, 1991). Occupational human capital refers to capabilities to perform certain tasks that can be used across industries and firms, but require an extended specialized knowledge. While general human capital is often used when analysing human capital in top management, occupational human capital is particularly relevant for knowledge workers within clearly defined occupations (Mayer et al., 2012). These occupations are usually within knowledge-based activities (Castanias & Helfat, 1991), because they often require a high level of professional skills. Examples of such occupations are accountants and attorneys (Mayer et al., 2012).

External providers which specialize in certain occupations tend to attract and employ more talented workers than in-house functional departments (Mayer et al., 2012). Because occupational human capital reaches across industries, workers in these specialized occupations can acquire a wider range of capabilities and knowledge, which can later be employed in several industries. This individual professional development that the specialized employers provide is highly attractive to workers in these fields. Because the employees have specialized knowledge they are also more inclined to produce more efficiently within their field, which along with higher service prices ensures higher compensation for the work.

The in-house department on the other hand, will produce a narrower range of occupational activities, as they work on a more firm-specific level (Mayer et al., 2012). Consequently, these departments are unable to make the same incentive structures for development of occupational human capital. Thus, in-house departments cannot attract the same talented workers by promising the same level of professional development. Because of this, specialized external suppliers are likely to accumulate superior occupational human capital.

Mayer et al. (2012) find that outsourcing is more likely in knowledge work that requires relevant occupational human capital, where external specialists have more expertise. Although specialized firm services are costly, the study finds that firms choose to outsource services when the value of occupational knowledge is superior to the service costs. The incentives for outsourcing are stronger when the value of the activity is high, and the negative consequences associated with errors are large.

2.3.4 Human Capital in the Patent Application Process

From the patent application perspective, the need for relevant specific human capital for any given patent will affect whether the firm performs the process internally or chooses to outsource it to external specialists (Mayer et al., 2012). The characteristics of the patent will indicate what kind of human capital is relevant in each patent application process. The more the firm holds of the firm-specific or industry-specific human capital that is relevant for the patent, the more likely the firm is to choose to perform the patent application process internally. Because the human capital held by the firm is based on accumulation from previously processed patent applications, the decisions for future patents of certain characteristics is likely to be the same as the decision made for earlier patents with these characteristics. Hence, characteristics of patents that have previously been processed internally

in the firm, indicates what kind of human capital has been accumulated. The more occupational human capital is considered to be relevant in the process, the more likely the firm is to seek external occupational expertise from professional law firms. Mayer et al. (2012) defines patents within *Highly Contested Areas* as patents in fields of strong competition, where the risk of having a patent litigated is high. These patents are considered to require occupational human capital, in terms of specialized knowledge from patent attorneys, because the negative consequences of a weak patent are likely to be higher in these areas than in others. Patents granted within highly contested areas between 1990 and 2000 were approximately 6,5 times as likely to be litigated as an average patent. Mayer et. al. (2012) also found that a large internal staff size negatively moderated the effect that the relevance of external occupational human capital had on outsourcing patent application processes. They accounted this to firms with large internal staffs being more likely to possess significant amounts of occupational human capital themselves, and also more capable of developing the occupational human capital further. This because in-house patent attorney may be connected to outside experts and receive more information about new developments.

Through the interviews of managers, the researchers found capacity to be of little importance when it comes to outsourcing patent application processes (Mayer et al., 2012). Managers noted that outsourcing to external law firms required very time-consuming coordination between the two firms, and consequently for the internal staff there “wasn’t any time saving at all” with outsourcing the process. This challenges lack of capacity as a classic reason for outsourcing.

3. Model and Hypotheses

Based on our research question and the theoretical background, we present the following hypotheses for the study:

H1: The more relevant firm-specific human capital that is accumulated in the firm, the less likely the firm is to outsource the patent application process.

H2: The more relevant industry-specific human capital that is accumulated in the firm, the less likely the firm is to outsource the patent application process.

H3: If occupational human capital is particularly relevant to the patent application process, the firm is more likely to outsource the process.

The first three hypotheses are based on the previous research by Mayer et al. (2012), and aims to examine the effect of specific human capital on the outsourcing decision. In addition, we propose a fourth hypothesis, testing for the effect of internal capacity on the outsourcing decision. The reason for this hypothesis is the conflicting claim that outsourcing of the patent application process is not time-saving, and the wide acknowledgement of outsourcing to often be capacity related.

H4: The more internal capacity the firm has, the less likely the firm is to outsource the patent application process.

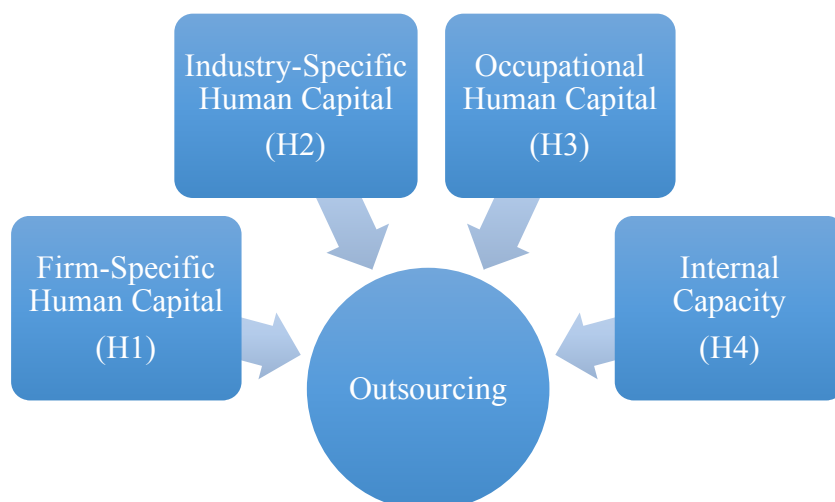


Figure 1

4. Research Design

In the research strategy, we consider the steps of our study. The aim of this study is to examine the effect of human capital and internal capacity on the firm's decision to outsource the patent application process.

The sample for our analysis consists of private American firms listed on the Fortune 500 ranking between 2005 and 2012. The study is based on patent data and is thus a quantitative study. The data is secondary data which is collected from databases available through PatentsView, USPTO and OECD. The patents from which our data derives are granted to the firms in our sample within the timeframe of 2005 to 2012. Information on the firms' revenues and internal staff size is collected from the sources Compustat and ALM Legal Intelligence respectively. Although the data is longitudinal, we choose to treat it as cross-sectional data, instead of panel data. We do this because our interest lies in the differences between patents, not in developments over time.

After the data is collected, we identify whether the application process for each patent was outsourced or processed internally. This identification is a result of assumptions and controls. Further, we estimate the accumulated levels of relevant specific human capital in each firm at the time of the patent grants, as well as identify whether occupational human capital is particularly relevant to any of the patents. Based on the yearly internal staff size and the total revenues of each firm, we also estimate the capacity of each firm's in-house legal staff.

When the estimations have been done, we conduct a logistic regression. The logistic regression analyses the relationship between the variables measuring the relevant human capital, as well as the capacity of the in-house legal staff, and the outsourcing decision, represented by a binary variable.

In section 5.2.1. and 5.5 respectively, we address the ethical considerations and limitations of our data collection and analysis. Section 6 provides a discussion of the findings in the study before the conclusions are drawn in section 7.

5. Methodology

5.1 Sample

In this study, we use a non-randomised sampling method. Ideally, we would like our analysis to be representative for all firms. Still, what is most crucial is that the sample enables us to answer the research question (Saunders, Lewis, & Thornhill, 2016). Our study does not aim to explain all the variation in the outsourcing decision. It is highly acknowledged that in most outsourcing decisions, the firms economic- and capacity constraints, as well as management strategy, are important factors. Because of this, we want a sample of firms which have resources enough to enable them to consider other factors when making the outsourcing decision. By choosing a sample of firms with similar resource capabilities, we ensure variation in our variables. Thus, our sample is a homogeneous sampling consisting of private American firms who were included in the Fortune 500 ranking between 2005 and 2012. The Fortune 500 ranking is a ranking of companies by their total revenues for their respective fiscal year (Fortune.com, 2017).

To analyse the outsourcing decision of patent application processes, the firms in our sample must have participated in an outsourcing decision of such a process. Consequently, they must have obtained at least one patent within the 8-year timeframe of our analysis. We find this to be the case for 113 firms, which thus constitutes our total sample. It should be noted that by using a non-randomised sampling method, the results of our analysis cannot be generalized to apply to all firms.

5.2 Data Collection

Patents are public records and data is available through multiple sources online. Thus, the data used in our study is secondary data, mostly representing the official information on any given patent. The main source is the PatentsView initiative, using data derived from The United States Patent and Trademark Office (USPTO) (PatentsView, 2017). PatentsView holds large databases containing information on all US granted patents from 1976 and patent applications from 2001.

From the website of The PatentsView we downloaded several datasets, each containing different information that can be found on the application of a patent. This includes a unique

patent identification number for every patent, identification numbers of the assignee of the patent and the attorney or law firm representing the patent, along with the names and organizations which these identification numbers represent. We also downloaded information on the listed correspondents on the patents and the backward citations made from one patent to another.

Two different datasets were downloaded for classification of the patents. The first one is the National Bureau of Economic Research (NBER) Classification (PatentsView, 2017). This classification enables us to divide our data into six main technological fields. We find this relevant in order to control for some level of fixed technology field effects. The second one is an International Patent Classification (IPC) dataset. This classification is more complex than the NBER-classification, containing specific technical classifications of each patent. From this classification dataset, we use the IPC-group, a 7-digit classification, to determine accumulation of industry-specific human capital in the firms. To serve this purpose the classifications need to be specific enough to assume that filing a patent within this classification will generate knowledge that will be relevant for subsequent patents within the same classification. The more specific the classification is, the more relevant we expect the generated knowledge to be.

Because of shortcomings in the data on the attorneys and law firms representing the patents, we downloaded a roster dataset on registered patent attorneys, provided by USPTO (USPTO, 2017). All attorneys practicing before the USPTO must be registered patent attorneys (Mayer et al., 2012). The roster dataset provided us with a list of attorneys and the firms that employ them. The information is an important part of identifying which patent application filings have been processed internally, and which have been outsourced, as this information is not specifically provided by the USPTO or PatentsView.

We also collected information about the number of claims made by each patent. This information is from the OECD-dataset of patent quality indicators (OECD, 2016). The claims are a specification of the property rights and the number of claims reflects the technological breadth of the patent (Squicciarini & Criscuolo, 2013). We included this because the scope of property rights claimed may affect the outsourcing decision, and we need to control for this.

From ALM Legal Intelligence we found information on the number of in-house attorneys employed by the firms (ALM Legal Intelligence, 2017). Although this number includes all

attorneys, not just the patent attorneys, it is an indicator of the legal capacity at each firm. The data is however only provided for the years the firms appeared on the Fortune 500 ranking. We address this issue in section 5.3.4. By combining this information with data from Compustat on the yearly total revenues of each firm (Standard & Poor, 2017), we are able to create an estimator of the capacity of the legal staff in each firm.

5.2.1 Ethical Considerations in Data Collection

There are some concerns with using secondary data. The data was not initially collected for the purpose of our analysis. One should always consider if using the data for other purposes than its initial intent could cause discontent with the subjects of the data, and whether the data is suitable to answer the research question. Because patents are public records and available to be downloaded by anyone, we do not consider it ethically problematic to use it in the analysis. Innovation and patenting are also common fields of research, and it could be argued that by partaking in patent activities one is knowingly becoming a part of innovation statistics. We will however refrain from identifying specific firms and drawing conclusions on their individual patent strategies.

5.3 Preparation of the Data

To analyse the dataset so that it might answer our hypotheses, a substantial amount of cleaning is necessary. In addition to capturing the patents relevant to our sample and timeframe, it is essential that the dataset can identify whether the patent application process of each patent has been outsourced, and this information is not provided by any of our sources. Earlier research on outsourcing in patent application processes has used different methods to identify whether a patent was outsourced (Mayer et al., 2012; Reitzig & Wagner, 2010). One of these methods is not appropriate for our data as the method is designed for European patent data, and our data cannot be interpreted in the same way. The other method is a comprehensive method based on visual inspection of each patent. However, because time is a limited resource, we develop a more efficient method based on a series of assumptions and controls.

The main dataset containing all patent identification numbers consists of 6 114 791 patents. The dataset holds identification codes of the assignees and attorneys of the patent. The first step is to eliminate all patents from the database that do not have an assignee identification code and an attorney identification code. Without these identification codes, it is not possible

to identify neither the assignee nor the attorney of the patent, making it impossible to determine whether the patent application process was outsourced. To avoid ambiguous patents, we also eliminate patents with multiple identification codes of attorneys and assignees.

5.3.1 Timeframe

Our analysis is based on patents granted from 2005 to 2012 (included), giving a period of 8 years. To be able to properly measure the accumulated human capital within the firms, it is necessary to also have information on patents prior to our timeframe. Thus, we add an additional 5 years, including all patents from 2000 to 2005 in our dataset as well. This way we can also measure the accumulated human capital in the firm at the time of the earlier grants. All patents granted prior to 2000 and all patents granted later than 2012 (2013 and onwards) we remove from the dataset. After we estimate the accumulated human capital for all the patents, we also remove the patents prior to 2005.

5.3.2 Sample Firms

The third step is assigning each firm in our sample with an identification number. Although all patents now have an assignee identification number, the same firms are found to have multiple assignee identification numbers, belonging to different divisions or branches of the firm. Because there is a great amount of variations in the spelling and formulations of the assignee organization names, each firm identification number is assigned to variations of the same assignee organization name, to gather all patents of the same firm under one firm identification number. Examples of variations that receive the same identification number are “3M” and “Minnesota Mining” and “Goodyear” and “The Goodyear”. The same identification number assigning process is repeated for the attorney roster dataset, to more easily determine the employment of the attorneys listed, which we elaborate on further in the following section.

5.3.3 Outsourced Definition

Most patents in the dataset lists either an attorney name or a law organization. The law organizations are either the name of the assignee firm or the name of a professional law firm. The attorney names listed can be attorneys internally employed by the assignee firm or attorneys with a private practice, or sometimes an attorney from a professional law firm, only

the law firm is not listed. Based on a series of controls and assumptions, we define which of the patents have been processed internally and which of them have been outsourced.

To determine whether the attorney or law organization listed on the patent is an external attorney or law firm, or an attorney employed by the patent assignee firm, we need to compare and match the information of the attorney or law organization listed on the patent with information about attorneys employed in the assignee firms. For the patents that list a law organization that is different from the assignee firm, we assume that this is an external law firm and that the patent application process has been outsourced to the mentioned law firm. We conduct a matching of the names of the law organizations with the name of the assignee firm for each patent. If the names are the same or the 5 first letters in the names are the same, the patent is labelled *in-house*. If they are not the same the patent is labelled *outsourced*.

The patents that do not list an attorney organization list an attorney name instead. Because the size of the dataset makes it unrealistic to visually inspect each patent application, we perform a manual control of 100 patents to see if a simplistic approach where all patents who do not list a law firm are labelled *in-house*, would be adequate for our study. By checking attorneys listed on patents who do not name a law organization, we find that only 37 % of the attorneys listed can be identified as internally employed attorneys. Consequently, we continue with a more comprehensive method for separating internally and externally processed patents.

By comparing the names and organizations from the attorney roster dataset to the attorney names and assignee firms in the main dataset, we can identify in-house attorneys. Because we also assigned firm identification numbers to the organizations in the attorney roster dataset, we can conduct a match between the attorney roster dataset and the main dataset. If the attorney listed on a patent belonging to a certain firm is also listed as an employee of the same firm in the attorney roster dataset, we assume that the patent application process has been done internally. We match this by checking if the first letter of the first name of the attorney, and the last name of the attorney are the same in both the main dataset and the attorney roster dataset, and if the law organization the attorney is listed to in the attorney roster file is also the same as the patent assignee firm. If this is the case, then the patent is labelled *in-house*.

To further identify internally processed patent application filings, we use information about the listed correspondents of the patent. One possible weakness with this approach is that the correspondent field is updated when the correspondent of the patent changes. This means that

a firm may have processed the application filing internally, and later listed an external law firm as the correspondent and vice versa. We only match correspondent to the firms that do not list a law organization, because the earlier matchings for these patents are satisfactory. For the patents that do not list a law organization, we label these *in-house* if the first or second correspondent is the same as the assignee firm, or if the first five letters of both names are the same. To clean up any false non-matches we further remove all punctuation and spaces from the columns of first- and second correspondent and assignees firms. We then redo the matching on correspondent. This enables us to match more patents despite spelling variations, adding accuracy to the definition.

The last step of our *outsourced* definition process is a visual inspection to control for any structural errors. We identify some structural errors in the correspondent matching, where the use of division names has prevented the matching. Examples of this are “at&tlegal” and “gelicencing”, which differs too much from the assignee firms “at&t” and “generalelectric” to be matched. We clear up these kinds of structural errors.

Other structural errors are that some of the attorneys listed on the patents are actually law firms and not individuals. For example, some of the patents list “G Michael Roebuck PC”. We separate all attorneys listing a denotation for a business entity type as one of their last names. This is the case for 35 attorney names. By conducting online searches, we can identify if these attorneys have been employed by any of the assignee firms, or if they are solely associated with their own law firm, or other professional law firms. Depending on the results of the searches, we make sure these patents are labelled accordingly.

Because we aim to explain outsourcing decisions unrelated to firm-fixed effects, we include only firms which both outsource and process patent application filings internally. Firms which consistently do one or the other during our timeframe are removed from the dataset.

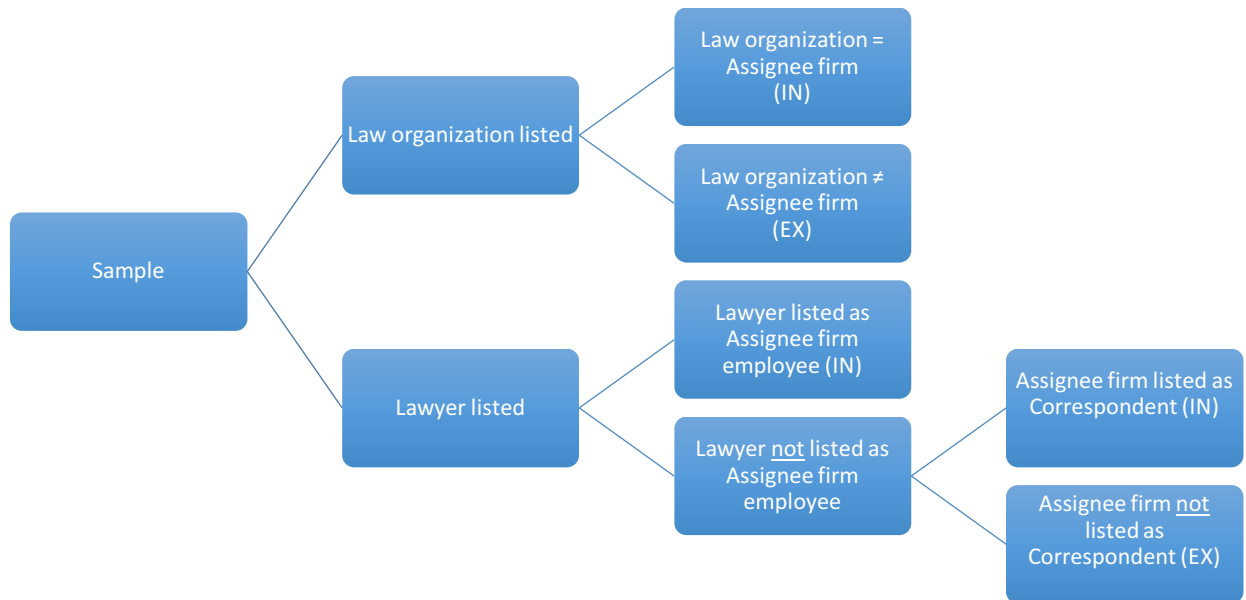


Figure 2: Visualization of Outsourced Definition. IN = Internally processed patent applications, EX = Outsourced patent applications.

5.3.4 Main Sample and Extended Sample

Because the data on internal staff size is only provided for the years when the firms were included in the Fortune 500 ranking, we use two sample sizes for our analysis. In addition to our main sample, we use an extended sample also including the patents granted to the firms in the years they did not appear on the Fortune 500 ranking. Thus, our main sample consists of 63 575 patents, and the extended sample of 117 150 patents. The use of the extended sample provides additional robustness to the effects of our first three hypotheses.

5.4 Research Variables

5.4.1 Dependent Variable

Outsourced

Outsourced is the dependent variable of our analysis. It indicates whether the patent application process was outsourced to an external law firm or kept internal. It is a binary variable that takes the value 1 if the patent application process was outsourced, and the value

0 if it was processed internally. The *Outsourced* variable is a result of the *outsourced* definition process described in section 5.3.3.

5.4.2 Independent Variables

Firm-Specific Human Capital

We measure the firm-specific human capital accumulated in the firm, relevant for the given patent at the time of the application filing. The measure is the number of citations by the focal patent to internally processed patents in the same firm. When filing for an invention to be patented, the inventor is obligated to disclose all “prior art”, meaning referencing or “citing” what prior patents and literature (including non-patent literature) has served as background for the invention.

The variable indicates to what extent the firm has previously processed other patents on which the focal patent is built. The assumption is that the experience from filing these patents will be relevant to the current filing process, because the relevant firm-specific human capital will be similar. To account for knowledge losses through forgetting, the measure includes only citations to patents that were granted five years prior to the year the focal patent was granted. Because we observe the distribution of this variable to be highly skewed, we log it prior to the analysis.

Industry-Specific Human Capital

We measure the industry-specific human capital accumulated in the firm, relevant to the given patent at the time of the application filing. The measure is the number of patent applications of the firm in the same 7-digit International Patent Classification (IPC) group, that were processed internally prior to the filing of the focal patent.

The variable indicates the experience the firm had from patent application within the industry domain in which the focal patent is assigned to, as this is considered to be relevant knowledge to the given patent application. To account for knowledge losses through forgetting, we include only patents granted within the last five years prior to the year of the current filing process, and patents granted prior to the focal patent in same year. We observe that the distribution of the variable is skewed and log it.

Occupational Human Capital

The *Occupational Human Capital* variable indicates if occupational human capital is considered particularly relevant to a patent. This is the case if the patent has cited another patent that has been litigated. Litigations occur more often within *highly contested areas*, meaning areas of high competition. It is costly and presumed to only be initiated if the patent is of high value and the infringement is considered to have significant negative consequences. A patent which cites litigated patents is thus more likely to belong to this type of area, where competition is high. Consequently, occupational human capital is particularly relevant to patents citing litigated patents. The variable is a binary variable taking the value 1 if the patent has cited a litigated patent, and the value 0 otherwise.

Internal Capacity

To estimate the capacity of the internal attorneys in the firms, we measure the number of attorneys employed per revenue-dollar in the year the patent was granted. The total revenues provide an indicator of the workload, comparable across all firms. If a firm hires an additional attorney without increasing revenues, the attorneys are assumed to have a smaller workload, and more capacity. The internal capacity consequently increases. If the revenues increase without the firm hiring additional staff, the internal capacity decreases. Internal Capacity is estimated:

$$Internal\ Capacity_t = \frac{Internal\ Staff\ Size_t}{Total\ Revenues_t}$$

, where t is the year the patent was granted

5.4.3 Control Variables

Prior Related Outsourcing

We control for prior related outsourcing by measuring the number of self-citations to outsourced patents. This variable is analogue to the variable *Firm-Specific Human Capital*, measuring the number of citations to patents of the same firm that were outsourced. We do this to ensure that the effect of *Firm-Specific Human Capital* variable is not just the effect of the total number of patents obtained by the firm. This way we can exclude the possibility of the effects being firm size related. Because the variable is skewed, we log it.

Prior Outsourcing in Industry Domain

We control for prior outsourcing by the firm in the industry domain of the focal patent. This variable is analogue to the *Industry-Specific Human Capital* variable and measures the firm's number of patents in the same IPC-group, where the patent application process was outsourced. The intention of this variable is the same as the *Prior Related Outsourcing* variable; to exclude firm size effects as a possible explanation. Because the variable is skewed, we log it.

Revenues

We control for total yearly revenues of the firm. We do this to ensure that the effects of the independent variable *Internal Capacity* are not simply a reflection of changes in the revenues.

Claims

We control for the number of claims of the patent. Claims determine the boundaries and the technological breadth of the patent (Squicciarini & Criscuolo, 2013), and might have some explanatory power in the outsourcing decision.

Technology Field

We add a dummy variable to indicate whether a patent belongs to a certain technology field, checking for 6 fields in total. The fields are collected from the NBER Classifications, and are *Chemicals*, *Computers and Communications*, *Drugs and Medical*, *Electrical and Electronics*, *Mechanical* and *Other Technologies*, with *Other Technologies* as the reference category. We include these dummy variables to control for fixed effects related to the technology field of the patent. The technology fields may vary in terms of their competitiveness, specialization and complexity.

Forward Citations

We include the number of forward citations, meaning the number of times the focal patent has been cited by other patents in their applications. Because older patents will have had a longer period to obtain forward citations, the measurement only includes forward citations up to five years from the grant of the patent. The variable will however still suffer from timeliness as the patents granted close to 2012 will not have had an equal amount of time to be cited as other patents. The distribution of this variable is skewed, and the variable is therefore logged.

5.4.4 Firm-Quarter Fixed Effects

When using our extended sample, we include a measurement of firm-quarter fixed effects. We do this to account for factors as the firm's capacity, economy, internal staff size, strategy and leadership. All of which are likely to influence the outsourcing decision. By including a measurement of time, in this case quarters, we also account for macroeconomics as well as changes in patent laws, regulations and procedures. We do not include this when analysing our main sample because we cannot test for firm-quarter fixed effects while also testing for internal capacity, as our measurement of internal capacity does not vary within the firm-quarter.

5.5 Limitations

5.5.1 Weaknesses in the Outsourced Definition

Our outsourced definition is based on a series of controls and assumptions. These assumptions may not hold in all cases, and consequently there are some weaknesses in our outsourced definition, and the *outsourced* variable. If the attorney listed on the patent is also listed as the correspondent, but is not registered in the attorney roster file, the patent may be labelled as *outsourced*, but the attorney could possibly still be an employee of the assignee firm, leading the patent to be falsely categorized as externally processed. If the first correspondent is the assignee firm and the second correspondent is an external law firm, the patent will be falsely categorized as internally processed, provided that the patent does not list a law organization. Further, the correspondent may have been updated since the patent application filing, and thus wrongly indicate one or the other definition.

To confirm the accuracy of our *outsourced* definition, we identified the 20 most frequently listed attorneys and conducted a manual online search to ensure that their employment history was consistent with the categorization of the patents they were listed to. We found that with few exceptions on patent level, this was mostly the case.

5.5.2 Construct Validity

It is important to emphasise that our independent variables do not account for all relevant specific human capital. There may be firm- or industry-specific human capital that is relevant for the outsourcing decision that is not captured by our measurements. Similarly, the

Occupational Human Capital variable is not a perfect indicator of when occupational human capital is particularly relevant, there may be other factors influencing the relevance of occupational human capital that our measure does not capture.

The Internal Capacity variable is not an exact measure of the internal capacity of in-house legal staff, it is merely an estimate based on assumptions of the relation between revenues and workload. The internal staff size may also change during the year, and our measurement does not account for this.

Despite the limitations of our variables we do consider them appropriate measures, and fit to answer the research question.

5.5.3 External validity

In terms of external validity, we evaluate whether the results of our study can be generalised to other groups or populations. We use a homogenous sample to define the selection of our data. Hence, we cannot generalise our results to count for other populations. We examine companies that are included in the Fortune 500 ranking. It is consequently not reasonable to believe that the results are valid for smaller firms. This because smaller firms possess limited resources or capabilities. Thus, smaller firms may not be able to develop the amount of human capital that is required, nor have resources to afford external attorneys. Additionally, the firms that are included in our study are US companies. There might be differences in organizational cultures and how firms choose to strategically shape their boundaries, preventing us to generalize our results to other geographical areas.

5.6 Analysis

5.6.1 Descriptive Statistics

| Variable | In-house | | | Outsourced | | | t-value |
|-----------------------------|----------|---------------------------|--------------------|------------|--------------------------|------------------|---------|
| | Patents | Mean(Std.Dev.) | Max(Min) | Patents | Mean(Std.Dev.) | Max(Min) | |
| Firm-Specific HC | 24 465 | 0,117 (0,481) | 4,043 (0) | 92 685 | 0,025 (0,174) | 3,332 (0) | 79,32 |
| Industry-Specific HC | 24 465 | 1,736 (1,614) | 5,714 (0) | 92 685 | 1,231 (1,539) | 5,617 (0) | 45,10 |
| Occupational HC | 24 465 | 0,192 (0,394) | 1 (0) | 92 685 | 0,268 (0,443) | 1 (0) | -24,43 |
| Internal Capacity | 16 665 | 0,006 (0,003) | 0,019 (0,000) | 46 910 | 0,005 (0,002) | 0,019 (0,000) | 24,77 |
| Revenues | 16 665 | 555 792,79 (44 625,43) | 255 112 4 019,6 | 46 910 | 47 812,55 (41 239,58) | 255 112 4030 | -7,766 |
| Related Outsourcing | 24 465 | 0,051 (0,260) | 3,999 (0) | 92 685 | 0,240 (0,588) | 5,069 (0) | -36,27 |
| Outsourcing Industry Domain | 24 465 | 01,412 (1,941) | 7,707 (0) | 92 685 | 3,461 (2,297) | 7,761 (0) | -48,98 |
| Claims | 24 465 | 18,694 (12,616) | 290 (1) | 92 685 | 20,600 (11,866) | 333 (1) | -22,05 |
| Forward Citations | 24 465 | 1,585 (1,168) | 6,767 (0) | 92 685 | 1,693 (1,220) | 7,331 (0) | -12,53 |
| Chemicals | 24 465 | 0,199 (0,399) | 1 (0) | 92 685 | 0,059 (0,236) | 1 (0) | 69,78 |
| Computers & Communication | 24 465 | 0,310 (0,463) | 1 (0) | 92 685 | 0,562 (0,496) | 1 (0) | -71,41 |
| Drugs & Medical | 24 465 | 0,086 (0,281) | 1 (0) | 92 685 | 0,041 (0,198) | 1 (0) | 29,08 |
| Electronics | 24 465 | 0,203 (0,402) | 1 (0) | 92 685 | 0,200 (0,400) | 1 (0) | 1,07 |
| Mechanic | 24 465 | 0,118 (0,323) | 1 (0) | 92 685 | 0,081 (0,272) | 1 (0) | 18,58 |

Table 1

Table 1 provides descriptive statistics of our data, featuring the extended sample. The statistics are divided in two respective subsamples; patents which are outsourced and those which are processed internally. The descriptive analysis gives a numeric overview and comparison between the variables in our dataset. In the extended sample, there are 24 465 patents that are processed by in-house attorneys, while there are 92 685 processed by external attorneys.

The observations for most of the variables are close to zero for both patents that are processed in-house and those processed externally. The measures for both Firm-Specific Human Capital and Industry-Specific Human Capital are logged due to skewness. We observe that for these variables, the mean is lower for patents that are outsourced than for patents that are processed internally. We also observe that occupational human capital more often is particularly relevant for patents which are outsourced, than for patents processed internally. Thus, between the two subsamples, the differences in our independent variables are consistent with our hypotheses.

In our main sample, 16 665 patents are processed internally, while 46 910 patents are outsourced. Thus, approximately 26 % of the total number of patents are processed internally. In the main sample, we also include the independent variable Internal Capacity. By looking at the variables' t-values, we can see that there are significant in variation within each variable except Electronics.

5.6.2 Correlation Matrix

The correlation matrix illustrates an overview of collinearity between the variables in our analysis. To test for collinearity, we measure how two variables vary as showed in table 2. Correlation close to -1 and 1 indicates strong correlation. We can see from table 2 that all our variables have a correlation coefficient between -0,5 and 0,49. We observe that our independent variables do correlate between -0,01 and 0,27. Internal Capacity and Industry-Specific Human Capital correlates by 0,27 and Firm-Specific Human Capital and Industry-Specific Human Capital correlates by 0,14. This indicates that there should be no further problems due to collinearity between our variables.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
|-------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (1) Outsourced | 1,00 | | | | | | | | | | | | | | | |
| (2) Firm-Specific HC | -0,23 | 1,00 | | | | | | | | | | | | | | |
| (3) Industry-Specific HC | -0,17 | 0,14 | 1,00 | | | | | | | | | | | | | |
| (4) Occupational HC | 0,07 | 0,05 | 0,02 | 1,00 | | | | | | | | | | | | |
| (5) Internal Capacity | -0,10 | -0,01 | 0,27 | 0,02 | 1,00 | | | | | | | | | | | |
| (6) Revenues | 0,03 | -0,02 | -0,09 | -0,05 | 0,03 | 1,00 | | | | | | | | | | |
| (7) Related Outsourcing | 0,17 | 0,06 | 0,02 | 0,18 | -0,01 | -0,03 | 1,00 | | | | | | | | | |
| (8) Outsourcing in Industry Domains | 0,42 | -0,12 | 0,48 | 0,12 | 0,23 | 0,04 | 0,20 | 1,00 | | | | | | | | |
| (9) Claims | 0,05 | 0,01 | 0,03 | 0,09 | 0,04 | -0,03 | 0,06 | 0,08 | 1,00 | | | | | | | |
| (10) Forward Citations | 0,04 | 0,05 | 0,08 | 0,22 | 0,09 | -0,01 | 0,14 | 0,17 | 0,17 | 1,00 | | | | | | |
| (11) Chemicals | -0,19 | 0,09 | -0,04 | -0,09 | -0,06 | 0,03 | -0,03 | -0,23 | -0,05 | -0,08 | 1,00 | | | | | |
| (12) Computers & Communications | 0,22 | -0,09 | 0,23 | 0,16 | 0,22 | 0,01 | 0,03 | 0,50 | 0,13 | 0,22 | -0,34 | 1,00 | | | | |
| (13) Drugs and Medical | -0,08 | 0,02 | 0,04 | 0,01 | 0,05 | -0,04 | 0,04 | -0,03 | -0,01 | -0,02 | -0,09 | -0,22 | 1,00 | | | |
| (14) Electronics | -0,03 | -0,01 | -0,05 | -0,11 | -0,02 | 0,07 | -0,01 | -0,13 | -0,05 | -0,10 | -0,17 | -0,42 | -0,11 | 1,00 | | |
| (15) Mechanical | -0,05 | 0,02 | -0,16 | -0,06 | -0,13 | 0,00 | -0,01 | -0,24 | -0,08 | -0,10 | -0,13 | -0,33 | -0,08 | -0,16 | 1,00 | |
| (16) Others | -0,01 | 0,02 | -0,15 | 0,01 | -0,19 | -0,11 | -0,01 | -0,16 | -0,01 | -0,04 | -0,12 | -0,29 | -0,07 | -0,14 | -0,11 | 1,00 |

Table 2

5.6.3 Regression Model

We analyse each variable's effect on the outsourcing decision with a regression model. Because the decision is whether to outsource or produce internally, the dependent variable is a binary variable (Wooldridge, 2013). This variable will be equal to 1 if the firm chooses to outsource the patent application process and 0 otherwise. Thus, we have a logistic regression model which gives us either a probit or a logit model as the best approach for the binary outcome. We find that the probit estimator is biased and consequently pay attention to the logit estimator.

In a binary response model, interest lies primarily in the response probability

$$P(y = 1|x) = P(y = 1|x_1, x_2, \dots, x_n)$$

where y is the dependent variable, and we use x to denote the full set of explanatory variables. In general, the probability of the dependent variable y to be 1 is given as a probability function as described below.

$$P(y = 1|x) = G(\beta_0 + \beta_1 x_1 + \dots + \beta_k x_k)$$

where G is a function taking on values strictly between zero and one: $0 < G < 1$, for all real numbers z . This ensures that the estimated response probabilities for y are strictly between zero and one. Thus, the regression of our main sample can be written as:

$$P(\text{Outsourced} = 1|x) = G \left[\begin{array}{l} \beta_0 + \beta_1 \text{FSHC} + \beta_2 \text{ISHC} + \beta_3 \text{OHC} + \beta_4 \text{IC} + \beta_5 \text{RO} + \\ \beta_6 \text{OD} + \beta_7 \text{Claims} + \beta_8 \text{FC} + \beta_9 \text{Chem} + \beta_{10} \text{Comp \& Com} + \\ \beta_{11} \text{Drgs \& Med} + \beta_{12} \text{El} + \beta_{13} \text{Mech} + \beta_{14} \text{Others} \end{array} \right]$$

For our extended sample, and by counting for the fixed effects firm and quarter, the regression can be written as:

$$P(\text{Outsourced} = 1|x) = G \left[\begin{array}{l} \beta_0 + \beta_1 \text{FSHC} + \beta_2 \text{ISHC} + \beta_3 \text{OHC} + \beta_4 \text{RO} + \beta_5 \text{OD} + \\ \beta_6 \text{Claims} + \beta_7 \text{FC} + \beta_8 \text{Chem} + \beta_9 \text{Comp \& Com} + \beta_{10} \text{Drgs \& Med} + \\ \beta_{11} \text{El} + \beta_{12} \text{Mech} + \beta_{13} \text{Others} + \gamma_1 \text{Firm} + \gamma_2 \text{Quarter} \end{array} \right]$$

| Abbreviation | Measure | Variable |
|---------------------|--|---------------------------------|
| FSHC | Logged Number of firm's own cited patents that were internalized | Firm-Specific Human Capital |
| ISCH | Logged number of internalized patents in same class | Industry-Specific Human Capital |
| OHC | Dummy = 1 if patent cites a litigated patent | Occupational HC |
| IC | Internal staff size divided by annual revenues | Internal Capacity |
| RO | Logged number of own cited patents outsourced | Prior Related Outsourcing |
| OD | Logged number of outsourced patents in the same class | Outsourcing in Industry Domain |
| Claims | Number of claims in focal patent | Claims |
| FC | Logged number of citations to focal patent | Forward Citations |
| Chem | Dummy variable, technology class | Chemicals |
| Comp&Com | Dummy variable, technology class | Computers and Communication |
| Drug&Med | Dummy variable, technology class | Drugs and Medical |
| EI | Dummy variable, technology class | Electronics |
| Mechanical | Dummy variable, technology class | Mechanical |
| Others | Dummy variable, technology class | Others |
| Firm Quarter | Control variable for fixed effects | Firm Quarter |

5.6.4 Interpreting the Coefficients

The coefficients of a logit model can be complicated to interpret (Hoetker, 2007). The coefficients from the logit model estimates whether the variable has significant effect and whether the effect is positive or negative. Thus, the coefficients do not describe how much the independent variable affect the probability of the event to occur. To understand these effects, it is possible to interpret the marginal effects of the variables. The marginal effect describes how much a change in an independent variable changes the probability of the outcome of the dependent variable. However, the marginal effect of a change in one independent variable depends on the probability of the dependent variable to take the value of 1, and thus depends on the values of the other independent variables. One approach is to set all other variables at

their mean, but the response for the mean for each observation can vary. It is therefore difficult to measure the effect of the independent variables. Because we use the logit model, we can also use the odds ratios as an interpretation of the coefficients, which is often preferable among researchers. Odds equal to 1 mean that the event is equally likely to occur. Odds less than 1 mean that the event is less likely to occur, and odds greater than 1 mean that the event is more likely to occur. The effect of a one unit change in the independent variable change the odds by a factor of $\exp(\beta x)$. However, a change in the odds does not describe any change in the probabilities of the event to occur.

In this study, we choose to present the coefficients from the logit regression because our interest lies in the direction and significance of the effect. For our main regression, Model 13, we also include the odds ratios and marginal effects in table 5 in the appendix.

5.6.5 Results

Table 3 and 4 provides the main results of our study. Table 3 provides the extended sample with 117 150 patents, while table 4 describes our main sample. By using two samples, we add the benefit of a robustness check to control for sample size. The Models are numbered from 1 to 14, and provide different variables in the regression to different sample sizes. Model 1 to 8 includes variables for the extended sample, while Model 9 to 14 provides the variables for our main sample.

From Model 11, we can see that all our independent variables are significant on a 1%-level. Firm-specific Human Capital, Industry-Specific Human Capital and Internal Capacity all affect the outsourcing decision negatively. The variable Occupational Human Capital affects the outsourcing decision positively. These results are all in line with our hypotheses. By adding the control variables Related Outsourcing and Outsourcing in Industry Domain in model 12, we observe a considerable change in the coefficients of all our independent variables. This effect is as expected, because the inclusion of these variables separates the effect of total patents from the effect of patents processed internally, ultimately controlling for firm size.

In our main regression in Model 13 we include the rest of the control variables. Two of the technology fields have significant effects on the outsourcing decision. Both Chemicals and Drugs and Medical affect the outsourcing decision negatively. This means that if a patent is registered within one of these technology fields, the firm is less likely to outsource the patent

application process than if the patent is associated with the reference category Other Technologies.

The addition of the variable Internal Capacity does not result in large changes in the coefficients of the other independent variables, as we observe when comparing Model 13 and Model 14.

When comparing the main sample with the extended sample, we observe from Model 14 and Model 7 that the coefficients of the independent variables Firm-Specific Human Capital, Industry-Specific Human Capital and Occupational Human Capital do not vary to a considerable extent. This indicates that the results are valid despite variations in sample size. We do however, observe that when adding the fixed effects to the extended sample in Model 8, there are some notable changes in the coefficients. Particularly for the variable Industry-Specific Human Capital, which is more affected by adopting the fixed effects than the other independent variables. This indicates that some of the effect of Industry-Specific Human Capital is a firm specific effect.

| Outsourced | 1 | 2 | 3 | 5 | 6 | 7 | 8 |
|--------------------------------|----------------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Firm-Specific HC | -1,629*** (0,026) | | | -1,608*** (0,027) | -0,951*** (0,033) | -0,922*** (0,033) | -0,725*** (0,037) |
| Industry-Specific HC | | -0,195*** (0,004) | | -0,169*** (0,005) | -1,162*** (0,010) | -1,138*** (0,010) | -0,593*** (0,013) |
| Occupational HC | | | 0,433*** (0,018) | 0,508*** (0,019) | 0,197*** (0,022) | 0,175*** (0,024) | 0,196*** (0,028) |
| Related Outsourcing | | | | | 0,717*** (0,032) | 0,742*** (0,032) | 0,561*** (0,033) |
| Outsourcing in Industry Domain | | | | | 0,987*** (0,008) | 0,953*** (0,008) | 0,481*** (0,011) |
| Claims | | | | | | 0,010*** (0,001) | 0,008*** (0,001) |
| Forward Citations | | | | | | -0,031*** (0,008) | 0,017 (0,01) |
| Chemicals | | | | | | -0,526*** (0,04) | -0,145** (0,056) |
| Computers and Communication | | | | | | 0,084* (0,037) | 0,220*** (0,052) |
| Drugs and Medical | | | | | | -0,390*** (0,047) | -0,032 (0,075) |
| Electronics | | | | | | -0,077* (0,038) | -0,075 (0,052) |
| Mechanical | | | | | | 0,059 (0,041) | 0,050 (0,057) |
| Constant | 1,453*** (0,007) | -1,620*** (0,010) | 1,233*** (0,008) | 1,586*** (0,011) | 0,645*** (0,013) | 0,608*** (0,037) | -4,392*** (0,228) |
| N | 117 150 | 117 150 | 117 150 | 117 150 | 117 150 | 117 150 | 117 150 |

Standard errors in parentheses * p < 0.05, ** p < 0.01, *** p < 0.001

Firm-quarter fixed effects are included in Model 8.

Table 3

| Outsourced | 9 | 10 | 11 | 12 | 13 | 14 |
|--------------------------------|----------------------|----------------------|----------------------|-----------------------|-----------------------|----------------------|
| Firm-Specific HC | -1,451*** (0,032) | | -1,482*** (0,032) | -0,977*** (0,040) | -0,951*** (0,040) | -0,918*** 0,040 |
| Industry-Specific HC | -0,233*** (0,007) | | -0,198*** (0,007) | -1,116*** (0,013) | -1,106*** (0,013) | -1,139*** (0,013) |
| Occupational HC | 0,502*** (0,023) | | 0,512*** (0,023) | 0,061** (0,031) | 0,070** (0,032) | 0,098** (0,031) |
| Internal Capacity | | -82,89*** (3,409) | -63,99*** (3,682) | -140,76*** (4,434) | -142,37*** (4,515) | |
| Revenues | | | -0,000*** (0,000) | -0,000*** (0,000) | -0,000*** (0,000) | |
| Related Outsourcing | | | | 0,995*** (0,050) | 1,029*** (0,050) | 1,028*** 0,049 |
| Outsourcing in Industry Domain | | | | 1,083*** (0,011) | 1,061*** (0,011) | 1,031*** (0,011) |
| Claims | | | | | 0,005*** (0,001) | 0,005*** (0,001) |
| Forward Citations | | | | | -0,059*** (0,011) | -0,066*** (0,011) |
| Chemicals | | | | | -0,432*** (0,047) | -0,542*** (0,046) |
| Computers and Communication | | | | | 0,072 (0,045) | -0,136** (0,044) |
| Drugs and Medical | | | | | -0,680*** (0,064) | -0,873*** (0,063) |
| Electronics | | | | | -0,013 (0,046) | -0,174*** (0,050) |
| Mechanical | | | | | -0,000 (0,049) | -0,045 (0,048) |
| Constant | 1,356*** (0,014) | 1,479*** (0,021) | 1,658*** (0,023) | 1,262*** (0,029) | 1,351*** (0,049) | 0,711*** (0,044) |
| N | 63 575 | 63 575 | 63 575 | 63 575 | 63 575 | 63 575 |

Standard errors in parentheses * p < 0.05, ** p < 0.01, *** p < 0.001

Table 4

6. Discussion

In this study, we wanted to examine to what extent human capital affects a firm's decision to outsource the patent application process. Our first hypothesis was that the more relevant firm-specific human capital that is accumulated in the firm, the less likely the firm is to outsource the patent application process. Our data revealed a significant effect of relevant firm-specific human capital on the outsourcing decision, supporting our hypothesis. The number of internally processed applications of patents that are cited by a patent, shows to be related to the decision of whether to also process the application of the citing patent internally. As these patents build on the same technologies and are likely to require similar knowledge of firm-specific factors, the firm's experience with the patent application process for one of the patents will likely be relevant in the next.

Our second hypothesis was that the more relevant industry-specific human capital accumulated in the firm, the less likely the firm is to outsource the patent application process. This hypothesis was also supported by our analysis. The more experience a firm has from filing patent applications within a certain industry, the more likely it is to choose to process the patent application internally, given that the invention is associated with this field. If the area of the invention is relatively new to the firm, and the firm lacks experience in this area, it is more likely to outsource the patent application process.

In our third hypothesis, we suggested that if occupational human capital is particularly relevant to the patent application process, the firm is more likely to outsource the process. As expected our analysis confirmed this hypothesis as well. When the risk of having the patent litigated is high, the firms will seek to access the occupational human capital of the external specialist by outsourcing the patent application process.

In the fourth hypothesis, we suggested that the more internal capacity that is available in the firm, the less likely the firm is to outsource the patent application process. Our findings confirmed this hypothesis. We observed internal capacity to have a negative effect on the outsourcing decision.

Our results corroborate the findings of Mayer et al. (2012) study. When comparing the odds ratios of the key variables in the two studies, the results are quite similar and do not show any large differences in effect. In this study, the odds ratios of outsourcing are slightly lower for

the independent variables firm-specific human capital, industry-specific human capital and highly contested areas.

The differences between the studies are possibly related to the differences in timeframes, for example as a result of development in industries as well as changes in competitiveness and risk. Higher competition in certain industries might create higher risks, causing firms to ensure that their patents are resilient by engaging external law firms. According to a report on patent litigation from 2016 (Barry et al., 2016), firms were under more pressure than ever to get their litigation strategies right as median damages awards were rising. Another timeframe related explanation could be changes in the perceived relevance of different management theories and methods. It should also be mentioned that our study is not limited to firms within certain fields, and the effect “overall” might be different from that in certain industries or for certain types of firms.

Though we find internal capacity to have a negative effect on the outsourcing decision, we cannot comment on the size of this effect. While outsourcing of patent application processes might not be considered time-saving, increased capacity with the internal legal staff could potentially allow them to be more thorough in their work, reducing the need of obtaining specific human capital through outsourcing. Because we cannot comment on the size of the effect, small decreases in internal capacity could still have minimal effect on outsourcing, in line with the arguments against time-saving through outsourcing. Large decreases would have an effect nevertheless, seeing as a partial or complete shutdown of the in-house legal department would unquestionably lead to increased outsourcing.

Although we find a significant statistical correlation between outsourcing and Occupational Human Capital, we cannot answer the question of what happens when occupational human capital is accumulated in the focal firm. It is considered easier and more common for this kind of capital to be accumulated in specialist firms, but this does not mean that occupational human capital does not exist in non-specialist firms. The firm might gain occupational human capital through working in different fields, or gain it by hiring staff with considerable occupational knowledge, for example attorneys previously employed by a specialist-firm. The study of Mayer et al. (2012) includes the testing of *internal staff size* as a moderator on the effect of occupational human capital on the outsourcing decision, in an attempt to capture some of the occupational human capital in the firm. In our study however, we include a variable measuring the internal capacity of in-house legal staff. The internal staff size itself is not an accurate

measure of occupational human capital, nor is the internal capacity. The level of occupational human capital would depend on the background and experience of the attorneys employed. Similarly, we do not have a measure for the occupational human capital in specialist firms, we only assume it would be more substantial, based on the benefits of specialist firms, and that it is the incentive to hire external specialists in the first place. However, the findings of Mayer et al. (2012) might explain some of the effect we find in our fourth hypothesis. If the internal capacity increases due to the hiring of additional employees, the level of occupational human capital in the firm is likely to increase, causing a negative effect on the outsourcing decision.

Overall, our results corroborate the findings of Mayer et al. (2012), and thus support their theory of a firm's outsourcing decision being driven by human capital. The more a firm has accumulated of both firm-specific human capital and industry-specific human capital, the more likely it is that the firm will keep the production of this activity internal. If the internal capacity of the firm increases, this too will lead to less outsourcing. However, If the patent application process requires occupational human capital, the firm is more likely to outsource it. Though our study provides statistical proof of the effects hypothesised, the question remains to which degree these effects are results of strategic outsourcing decisions, which may or may not be expedient, or whether they are merely a result of failure to re-evaluate old strategies. In the following paragraphs, we consider possible explanations behind the outsourcing decisions from which we have gathered our statistic results.

6.1 A Resource-Based Perspective

From the RBV we presented several incentives to strategic outsourcing, and we consider how some of these incentives might influence the outsourcing decision and the accumulation of human capital in the firm.

The external law firm might possess complementary capabilities to the capabilities of the focal firm which may benefit the quality of the patent application. For example, the firm may possess the beneficial amount of relevant firm-specific human capital, but lack the occupational human capital necessary if the patent is likely to be litigated. The firm can communicate the relevant firm-specific knowledge to the external law firm, and also benefit from the occupational human capital of the law firm. In this way, the patent application could meet the requirements of both firm-specific and occupational human capital. The same scenario occurs when the firms lacks industry-specific human capital. By combining the

complementary capabilities, the quality of the patent will increase, which is not only beneficial to the focal firm, but also to the external law firm. Increased quality of the “produced product” will reflect positively on the law firm, which in turn may lead to additional business assignments and new clients. When the firm and the law firm shares this common goal of a high-quality patent, the strategic relatedness between the firms facilitates communication and the firms can benefit from each other’s knowledge.

When the firm engages the law firm on multiple occasions, the cooperative experience can also be an explanation to why it continues with its sourcing patterns. With repeated cooperation with a specific law firm, the internal accumulation of specific human capital will suffer, but the benefits of the cooperation will increase. This is because the strategic relatedness becomes more evident and trust can be built up between the two. Low levels of specific human capital may be an indicator of a well-functioning exchange relationship. The firm may consider the benefits of the cooperation to exceed the potential utility of the specific human capital relevant in patent application processes.

6.2 Other Perspectives

Although our results confirm that there is a significant relation between human capital and the outsourcing decision, the decision could also be just a continuation of an old strategy. Mayer et al. (2012) mention governance inseparability as a potential explanation. Because of costs associated with moving a process, either between suppliers or from a supplier to an internal department (or vice versa), firms might continue to follow the regular pattern of outsourcing even when this is not the optimal decision for the transaction in question, or in this matter the patent in question. However, this is an unlikely explanation for our study. The analysis is only conducted on firms which both keep patent filing processes in-house and outsource some of them. Costs associated with moving the patent application process will therefore not be as significant, seeing that the firms are likely to already have an in-house law department for such processes. In the opposite situation, when considering to move the activity out of the firm, the supplier relationships are already established. As hiring external legal expertise is highly expensive, it is reasonable to assume that it would be beneficial accept costs of moving the process in-house to spare the sourcing costs. Especially considering that coordination between a firm and the external law firm is very time-consuming, and by managers outsourcing is therefore not considered to be capacity-saving at all.

Other studies on outsourcing of the patent application process, or in relation to the process have interesting findings that could be considered in strategic patent outsourcing decisions (Reitzig & Wagner, 2010; Steensma et al., 2015). Reitzig and Wagner (2010) argue that outsourcing the patent application process will entail knowledge losses that will decrease the performance of related activities in the vertical chain, specifically the identification of infringement of the patent. Thus, outsourcing could prevent accumulation of specific human capital in the firm (encouraging outsourcing even further), and also prevent firms from identifying competitors' infringements of those patents. This presents another trade-off consideration in the outsourcing decision. In competitive industries, the firms must choose whether to engage external expertise to ensure that the patent is resilient to litigation, or to accumulate as much of the specific human capital as possible to better protect the patent from infringement. Most firms will only litigate "economically important patents", seeing as litigation is "costly and time-consuming", which further complicates the decision (Lerner, 1994).

Steensma et al. (2015) find that outsourcing in some cases can be used as a strategic instrument to avoid disclosing prior art in order to obtain broader patents. Because one is obligated to disclose all relevant prior art when filing a patent application, firms may seek to outsource the task to someone who is less likely to know of all the relevant prior art, or at least in a position to argue plausible deniability. External attorneys are less likely to be sanctioned for these types of errors, because they are not expected to have an equally deep knowledge of the firm's history as an in-house attorney. The firm-specific human capital can be considered an obstacle in this kind of strategy, and high levels of accumulated firm-specific human capital would thus be an incentive for outsourcing.

Although this kind of practice may not be common, the study does present a possible weakness in the engagement of external law firms as a measure to ensure resilient patent. To obtain the resilient patents associated with the occupational expertise, firms must consider if the firm-specific human capital can be communicated sufficiently to the external law firm to achieve the advantage expected.

7. Conclusion

In the conclusion, we summarize our research and our findings. Further, we consider the implications that the study might have for firms engaging in outsourcing decisions related to knowledge-work. Finally, we provide suggestions for future research within this field.

7.1 Summary

The study corroborates as well as reinforces the findings in the study by Mayer et. al. (2012). By applying a more recent timeframe, we confirm the continuing relevance of human capital in the outsourcing decision. Secondly, we contribute by adding a measure of internal capacity to the research, testing the relevance of this element on the outsourcing decision as well. The study thus provides robustness for both the results of the analysis, and for the findings of previous researchers.

The purpose of the study was to answer the following research question:

In what way does human capital and internal capacity affect the firm's decision to outsource a patent application process?

In order to answer this question, we collected patent data from the multiple databases, in addition to information about the yearly total revenues and legal staff sizes of the sample firms. The sample consisted of private American firms listed on the Fortune 500 ranking between 2005 and 2012, which sometimes will outsource the patent application process, and sometimes keep it internal.

We first identified which of the patent application processes had been outsourced. We then estimated the accumulated levels of relevant firm-specific and industry-specific human capital in the firm, at the time of each patent grant. We also determined whether occupational human capital had been particularly relevant for the given patent application process. By combining information on internal legal staff size with the yearly total revenues of each firm, we were able to create a ratio representing the capacity of the in-house attorneys. Finally, we analysed our data with a logit regression model to see how the specific types of human capital, as well as the internal capacity, affected whether the patent application process was outsourced.

Our findings indicate that the effect of specific human capital on the outsourcing decision is still significant and relevant today. When a firm has higher accumulated levels of relevant firm-specific or industry-specific human capital, the firm is less likely to outsource the patent application process. If the invention is associated with a highly contested area, so that occupational human capital is particularly relevant to the patent application process, the firm is more likely to outsource the process. Further, the findings indicate that internal capacity of the legal staff is negatively related to outsourcing a patent application process. These findings summarize our research question and explains how human capital and internal capacity affects the firm's decision to outsource the patent application process.

7.2 Implications

Our findings suggest that firms should consider the impacts on the development of human capital when making outsourcing decisions in knowledge work. The human capital in the firm will influence the sourcing decisions. However, these decisions will also influence the human capital in the firm, as human capital by definition is “any stock of knowledge or characteristics the worker has (either innate or acquired) that contributes to his or her “productivity”” (Acemoglu & Autor, 2011). Consequently, as the strategic risks of outsourcing includes losing critical or cross-functional skills, outsourcing the knowledge work is likely to affect the human capital in the firm. These risks should be considered alongside incentives for outsourcing, such as the value of capability complementarity, strategic relatedness and cooperative experience. All of these factors are important when establishing a long-term patent strategy.

7.3 Suggestions for Future Research

In our study, we have examined the effects of specific types of human capital on the outsourcing decision. Still, there are aspects of this research we would have enjoyed investigating further. It would be interesting to see a qualitative case study featuring a specific firm, to map their outsourcing pattern in patent application processes and to obtain precise strategic reasons for specific outsourcing decisions. This information could later be related to quantitative patent data to examine the possible relations.

Further, many aspects of the occupational human capital definition remain unexplored. In the future, it would be interesting to see how other measures of both the accumulation and necessity of occupational human capital related to outsourcing decisions.

Other studies that could be interesting to conduct involve the expansion of the validity of the findings to smaller firms or different geographical contexts, and studies on human capital and outsourcing in other knowledge-based activities, to further generalize the findings.

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8. Appendix

| Outsourced | Odds Ratio | Marginal Effect |
|--------------------------------|---|-----------------------|
| Firm-Specific HC | 0,386*** (0,016) | -0,100*** (0,004) |
| Industry-Specific HC | 0,339*** (0,004) | -0,113*** (0,002) |
| Occupational HC | 1,092** (0,034) | 0,009** (0,003) |
| Internal Capacity | 2,62e ⁻⁶¹ *** (1,18e ⁻⁶⁰) | -14,619*** (0,493) |
| Related Outsourcing | 2,810*** (0,140) | 0,110*** (0,005) |
| Outsourcing in Industry Domain | 2,856*** (0,031) | 0,110*** (0,001) |
| Claims | 1,006*** (0,001) | 0,001*** (0,000) |
| Forward Citations | 0,943*** (0,010) | -0,006*** (0,001) |
| Chemicals | 0,626*** (0,029) | -0,049*** (0,005) |
| Computers and Communication | 1,057 (0,048) | 0,006 (0,005) |
| Drugs and Medical | 0,497*** (0,032) | -0,073*** (0,007) |
| Electronics | 0,966 (0,044) | 0,004 (0,005) |
| Mechanical | 0,980 (0,047) | 0,002 (0,005) |
| Constant | 3,384 (0,161) | |
| N | 63 575 | 63 575 |

Standard errors in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

Marginal effects calculated by holding other variables at their mean.

Table 5