

Firm-Specific, Industry-Specific, and Occupational Human Capital and the Sourcing of Knowledge Work

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Whereas capability differences are known to impact governance decisions, what drives heterogeneity in firm capabilities? We propose that capability differences may arise from governance choices related to the focal activity and study how firms accumulate capabilities in the firm-specific, industry-specific, and occupational human capital necessary to perform knowledge work. We theorize that prior outsourcing decisions influence the development of firm- and industry-specific human capital and that buyer–supplier differences in the management of skilled employees can produce systematic differences in capabilities based on occupational human capital. Additionally, we explore some contingencies in the development of these types of human capital and their impacts on outsourcing knowledge work. These propositions are tested with a unique data set on the outsourcing of legal work involved in filing patents (i.e., patent prosecution).

Key words: human capital; organizational capabilities; knowledge-based view; outsourcing; knowledge work; resource-based view; transaction cost economics

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Introduction

Knowledge-based business activities have become an increasingly important component of firm performance (Grant 1996, Itami 1997, Kogut and Zander 1992), and simultaneously, the market for outsourced knowledge work has also been growing rapidly (e.g., in fields such as accounting, consulting, information technology (IT), law, marketing, product design, and research and development (R&D)). Statistics from the U.S. Census indicate that this economic sector's GDP value added nearly doubled in the decade 1998–2008, whereas manufacturing grew by a mere 24%.¹ Many firms perform some of the same knowledge-based functions internally while simultaneously outsourcing others to external suppliers. Therefore, understanding how firms decide to source knowledge-based projects and how these decisions are influenced by the firm's development of valuable knowledge-based competencies is important for management research. Sourcing decisions have been addressed by several theories that highlight different but potentially complementary motivations, but in prior work, the origins of firm capabilities that subsequently affect boundary choices are typically either unexplained or based on serendipitous experience (e.g., Argyres 1996, Leiblein and Miller 2003, Mayer and Solomon 2006). In this paper, we examine how these differential

firm capabilities may arise and in turn influence outsourcing decisions, especially in the context of knowledge work.

We develop and examine the proposition that knowledge-based capabilities may have “governance” origins; specifically, capabilities may arise from prior make-or-buy choices and buyer–supplier differences in the management of skilled employees. Because it is widely acknowledged that firms' knowledge and capabilities are primarily situated in their human capital (HC) (Grant 1996, Felin and Hesterly 2007), we draw on prior research to develop a deeper understanding of the different types of HC required for skilled knowledge work (e.g., Becker 1964; Castanias and Helfat 1991, 2001; Gibbons and Waldman 2004; Kambourov and Manovskii 2009). We advance our ideas by focusing on the firm-specific, industry-specific, and occupational HC relevant to performing knowledge projects and examining the extent to which firms may have built capabilities in each of these types of human capital as a result of the governance-based logics noted above. In turn, we hypothesize and test how these presumed differences in human capital-based capabilities will affect the outsourcing decision for individual knowledge projects.

Our research makes four main contributions to the capabilities and outsourcing literatures. First, we draw on and apply existing typologies of human capital to

develop a logic of capability development at the functional level within firms. Although prior research has largely employed human capital typology to understand firm capabilities derived from top-level management (e.g., Castanias and Helfat 1991), Castanias and Helfat (2001) also note the potential to extend the analysis to functional HC, which we hereby realize.

Second, and most importantly, we develop two central logics of capability development within an HC framework, which in turn impact outsourcing decisions. The first logic relates to the impact of *prior* governance (make-or-buy) choices on the firm's human capital. In a recent theory paper, Argyres and Zenger (2012) propose that current capabilities may ultimately have their roots in the firm's prior boundary choices. Building on their work, we advance our understanding of the dynamic relationship between prior sourcing decisions, their influence on the accumulation of human capital through learning by doing (specifically in relevant firm-specific and industry-specific HC), and the impact on subsequent outsourcing decisions. The second logic, which draws on ideas relating to diminished incentives and selective intervention within firms relative to markets (Williamson 1985, Foss 2003), highlights the differences between (client) firms making sourcing decisions and specialized suppliers in the way they govern their employees. In particular, suppliers specialized in a particular occupation (e.g., law, accounting, IT) may be better able than buyer (client) firms to incentivize and enable employees to develop very high levels of occupational HC. Taken together, these logics suggest that managers walk a fine line with their firm boundary choices—excessive outsourcing can “hollow out” the firm's knowledge (Reitzig and Wagner 2010) and increase dependence on suppliers (Ring and Van de Ven 1994, Langlois and Robertson 1995), whereas excessive integration can hurt the firm's competitive position if superior human capital (and associated capabilities) exists in the market.

Third, recognizing that the relevance of human capital for knowledge work does not exist in a vacuum, we examine a number of contingencies that impact how different types of HC are accumulated and linked to outsourcing decisions. To begin with, we examine how firm-specific HC and industry-specific HC relevant to a particular knowledge project moderate each other's impact on outsourcing. Furthermore, we study how projects with certain attributes may rely more heavily on particular types of human capital; for example, a high level of occupational HC may be essential for projects in highly contested areas. Finally, we examine the potential for firms to attenuate the theorized supplier advantage in occupational HC by investing in the development of large internal functions within which occupational expertise can be better developed and maintained.

Fourth, we employ detailed project-level data from patent prosecution work—that is, the work of drafting, filing, and obtaining patents—to test the effects of different types of human capital on outsourcing decisions. Patent data provide precise measures of our key human capital variables and facilitate robust controls for alternative explanations. Thus, our study lays the groundwork for future research that seeks to test microanalytic theories of firm capabilities based on human capital. We complement our large sample analyses with unstructured interviews of managers, which enable us to further corroborate our findings and discuss their theoretical and managerial implications.

Theory and Hypotheses

Historically, the implications of transactional governance (informed by transaction cost economics (TCE)) and capabilities (informed by resource-based view (RBV)) for firm boundaries were often characterized as being at odds (e.g., Conner and Prahalad 1996, Ghoshal and Moran 1996, Foss 1996, Kogut and Zander 1996, Williamson 1996); however, their central tenets appear to be more compatible than antithetical, and subsequent research has sought to realize these complementarities in various ways. One approach has sought to examine how capabilities—both productive and governance related—help to explain the effective governance of transactions within and across firm boundaries (Mayer and Salomon 2006, Argyres and Mayer 2007). Another approach has acknowledged that both capability differences and transaction costs are necessary for a theory of firm boundaries, and has argued that transaction costs are often endogenously determined by capability differences and resulting firm specialization (Langlois and Robertson 1995, Jacobides and Winter 2005). In the current paper, we seek to advance the increasing integration of governance and capabilities views in a slightly different way. Echoing Argyres and Zenger (2012), we propose and test a theory that focuses on how governance leads to the development of capabilities. In so doing, we also develop a potential response to a foundational but challenging question in RBV research (Barney 1986, Dierickx and Cool 1989): What are the main sources of interfirm differences in capabilities?

We begin with the human capital framework we adopt to develop our theory of capability development in knowledge work. Knowledge work essentially consists of activities, tasks, or projects (henceforth, projects) that require the application of knowledge to solve business problems. For example, a market may need to be researched, a business plan developed, a legal document prepared, or a product designed. Accordingly, we focus on the expertise needed to competently solve business problems and execute knowledge projects (March 1991, Simon 1991), and such expertise is ultimately rooted in

human capital. Thus, although there are many epistemological debates on what essentially constitutes knowledge (Spender 1996), our view of firm knowledge is that it is composed of the expertise and skills embedded within the human capital of the firm's employees. Therefore, exploring the implications of different *types* of human capital may be helpful for explaining capability development.

Building on Becker's (1964) pioneering work, Castanias and Helfat (1991, 2001) advance three main types of managerial human capital that underlie firm capabilities—firm specific, industry specific, and general.² The three types are conceptually nested, with firm-specific human capital being the most narrowly applicable and general human capital being the broadest. In this paper, we employ and extend the Castanias and Helfat (1991) typology by shifting its focus from top managers to skilled employees at the functional level within the organization who are responsible for knowledge-based activities. Within the broad Castanias and Helfat (1991) category of general human capital, we focus on occupational HC, a type of general HC that is highly relevant for knowledge workers who are members of relatively well-defined occupations or professions (e.g., law, accounting, engineering) (Kambourov and Manovskii 2009, Shaw 1984). Occupational expertise can be a significant driver of performance in knowledge work (e.g., an expert IT engineer or lawyer will likely deliver a far superior work product), and by highlighting this category, we hope to direct more research attention to the importance of this type of general HC. As a practical matter, many dimensions of general HC are manifested in occupational HC—e.g., more intelligent attorneys are also likely “better lawyers”—and to that extent they are included in our approach. We do not mean to imply that other nonoccupational aspects of general HC are not relevant, and indeed, we cannot empirically rule out their impact on capability development and sourcing decisions. However, our theorizing about capability development in general HC relies in part on suppliers who are specialized along occupational lines, and that logic does not translate fully to other types of general HC (outside occupational HC).

In summary, we focus on three types of human capital—firm-specific, industry-specific, and occupational. To further clarify our framework, we define these HC types and explain how they apply in the empirical context of our study, namely, patent legal work. Firm-specific HC refers to knowledge and skills that are unique to a firm, such as knowledge about specific strategies, processes, and technologies of the firm (Castanias and Helfat 1991). For example, effective patent legal work may require firm-specific knowledge about the relationship of the focal patent to the relevant product line or technological trajectory of the firm. Industry-specific HC refers to knowledge about the industry setting or domain in which a project is situated, and thus

it is redeployable across the (limited) set of firms with projects in the same industry domain (Castanias and Helfat 1991). Because patents are filed on inventions located in different technological areas, knowledge about the technological domain of a patent is an important type of industry-specific HC needed to file and prosecute patents. Finally, occupational HC consists of the knowledge and skills required to perform work within a professional or functional area, and as a type of general HC, it is most easily transferred across industry and firm settings (Kambourov and Manovskii 2009, Shaw 1984). Because industries often develop around an occupation, we should be careful to distinguish between occupational and industry-specific HC, whereby the former refers to knowledge and skills in the “task domain” of the focal project and the latter refers to the “application domain” of the project. For example, legal work on a biotechnology patent requires knowledge about both patent law and biotechnology, and in this context, occupational HC refers to knowledge about patent law and industry-specific HC refers to knowledge about biotechnology.

Before moving forward with our theorizing, we note one final wrinkle in applying human capital typologies to understand capabilities and outsourcing in knowledge work. Whereas all firm-specific and industry-specific HC may matter to performance at the top management level (Castanias and Helfat 1991, 2001), the human capital relevant to project-level performance may be a much narrower subset of these broad groupings.³ Top managers need to know a great deal about the entire firm and the whole industry to make the best decisions. When looking at functional-level knowledge work, however, a narrower range of human capital about a specific firm context (e.g., a specific product line) or a specific industry domain (e.g., a specific application area such as digital signal processing) may be more relevant. Recent labor economics research has also begun to highlight the value of focusing on such narrow “task-specific” categories of human capital (Gibbons and Waldman 2004, Gathmann and Schönberg 2010). To ensure clarity and precision, we refer henceforth to the narrower subsets of human capital that matter specifically to a focal project by labeling them “relevant” (firm- or industry-specific) HC. Drawing on the three types of human capital—firm specific, industry specific, and occupational—we now turn to developing our theoretical arguments about how transactional governance affects the firm's capability development and in turn drives outsourcing decisions on the focal project.

Firm-Specific Human Capital

When knowledge projects are closely tied to a unique technology, organizational unit, or strategic area of the firm, effective problem solving for the completion of

the project requires significant firm-specific human capital. For example, when a patent relates to a well-established product of the company, understanding the market position, complementary technologies, and competitive background of the product would be invaluable for writing and obtaining a legally meaningful patent. External suppliers face distinct disadvantages, relative to internal departments, in the development of firm-specific HC because they may not share a common language, relationships, or a sense of identification that exists among departments within a firm (Grant 1996; Kogut and Zander 1992, 1996). Suppliers may also be reluctant to make investments in firm-specific HC (Williamson 1975) and will have to be compensated to do so. Moreover, because of time compression diseconomies (Dierickx and Cool 1989, Knott et al. 2003), suppliers may be unable to quickly develop the same depth of firm-specific HC as internal providers. Because firm-specific HC tends to be associated with strategically important areas of the firm, outsourcing to suppliers can also raise appropriability and monitoring issues (Mayer and Nickerson 2005).

Despite these traditional rationales for the internalization of projects needing substantial firm-specific HC, buyers and suppliers generally have longer histories than a single transaction, and the supplier may have completed related projects for the client in the past. Argyres and Liebeskind (1999) refer to governance inseparabilities whereby outsourcing choices made for one transaction materially influence the choice sets or relative costs for outsourcing future transactions. Thus, suppliers may have already developed relevant firm-specific HC from their experience in executing closely related projects for the firm. The outsourcing of prior related projects may also improve performance in the focal project because the parties learn how to effectively work and contract with each other (Langlois and Robertson 1995, Mayer and Argyres 2004). Additionally, prior experience may mitigate appropriability concerns because of the deployment of relational governance mechanisms and the development of mutual trust and understanding between the firms (Gulati 1995, Uzzi 1996). By contrast, if closely related projects were internalized in the past, the relevant firm-specific HC would be built up within the firm instead of suppliers, and the development of relational governance with suppliers would also be curtailed. Consequently, it is not simply the need for firm-specific HC but the extent to which the relevant firm-specific HC has been retained internally that should be associated with a higher probability of internalization on the focal project.

HYPOTHESIS 1 (H1). *Firms are less likely to outsource knowledge projects the greater their relevant firm-specific human capital developed by performing prior related projects internally.*

Industry-Specific Human Capital

The successful execution of a knowledge-based project also requires an understanding of the industry setting in which the activity will occur. Knowledge work generally involves trade-offs between different task dimensions, and a good understanding of the application domain is necessary to make such trade-offs and exercise creativity. When (client) firms diversify into new areas, they may initially lack the in-house industry-specific HC required to effectively perform in these areas. For example, even a firm with a strong IT department may not feel confident in developing a new type of software application in-house for a new industry context (e.g., a bank diversifying into online trading). As such, organizational decision makers face an important strategic choice: they may decide to rely on the industry-specific HC of external suppliers, or they may choose to develop it internally and rely on external sources only in limited situations (Parmigiani 2007). Although the firm may make a sourcing decision based on relevant current considerations (e.g., workload, staffing budgets, time pressures, transaction costs), this decision can have lasting impacts on its future development of industry-specific HC, thus shaping the industry domain capabilities of the firm and influencing subsequent outsourcing decisions.

Firms may attempt to learn by working closely with external suppliers and thus seek to develop their industry-specific HC (Rothaermel et al. 2006, Parmigiani and Mitchell 2009). However, several factors may limit the effectiveness of this strategy. First, suppliers may not want to share their knowledge with the client—they will provide the good or service, but not necessarily help their clients learn it so well that they could do it themselves. Second, industry-specific HC may be difficult to learn because of tacitness, causal ambiguity, proprietary technology, or other appropriability barriers. Therefore it is likely to be more difficult to transfer industry-specific HC across firms than within organizational boundaries (Darr et al. 1995, Argote and Ingram 2000). Finally, to the extent that industry-specific HC is built up through learning by doing in a given domain (Hatch and Dyer 2004) and requires constant improvement and updating, reliance on suppliers creates and repeatedly replenishes supplier capabilities, leaving client firms to continually play catch-up. As suppliers develop greater familiarity with the firm and its technologies (and the two learn to work together), the firm's lack of capabilities in industry-specific HC can become an entrenched driver of further outsourcing.

Alternatively, organizational decision makers may decide to develop industry-specific HC within the firm. Although firms can hire new employees and/or invest in training to partially address their industry-specific HC needs, it will ultimately be necessary to “learn by doing” knowledge projects internally (Hatch and Dyer 2004). In dynamic, fast-moving domains in particular,

the challenges of learning from suppliers may be difficult to overcome without actually engaging in the relevant knowledge work. Overall, we conclude that the outsourcing of knowledge work will be less likely when the firm has developed relevant industry-specific HC through the internalization of prior projects in the same industry domain.

HYPOTHESIS 2 (H2). *Firms are less likely to outsource knowledge projects the greater the relevant industry-specific human capital developed by previously internalizing knowledge projects in the same domain.*

Interaction Between Firm-Specific and Industry-Specific Human Capital

When performing knowledge work, firm-specific and industry-specific human capital may both be relevant for a particular activity. For example, prosecuting a patent simultaneously requires knowledge about developments in the technological domain of the patent (industry-specific HC) and the role played by the patent within the firm (firm-specific HC). The issue we seek to address here is the interaction of firm- and industry-specific HC in predicting outsourcing decisions, which is a valuable addition to our understanding of how firms source knowledge projects. If the relevant firm- and industry-specific HC held by the firm are both low (e.g., because of prior outsourcing), there will be little internal capability to perform the project, and the tendency to outsource will likely be strong. However, when the firm develops a high level of one type of HC (firm specific or industry specific), we propose that this is likely to significantly reduce the tendency to outsource for two reasons: (1) an increased capability of the firm to execute the knowledge project and (2) coordination benefits the firm realizes from utilizing internal human capital instead of working with suppliers. The latter follows from the knowledge-based view (KBV), which argues that advantages in coordinating knowledge-based activities are the foundation of firms (Kogut and Zander 1992, 1996; Conner and Prahalad 1996; Nickerson and Zenger 2004). These coordination advantages stem from complex routines, communication channels, and a sense of identification within the firm, which make it more economical to transfer knowledge and cooperate on knowledge projects.

Therefore, because of the additional boost to internalization from the ease of intrafirm coordination of knowledge projects, the marginal effect of either firm-specific or industry-specific HC on internalization will be highest when the other HC is low and decrease as the magnitude of the other HC increases. In essence, once a firm is already high on one type of HC, higher levels of the second type increase firm capability to perform knowledge work but do not add much in additional coordination benefits. We expect that simultaneous high levels of firm-specific and industry-specific HC

will lead to the lowest probability of outsourcing; however, from a marginal impact perspective, the greatest marginal impact of firm-specific or industry-specific HC on outsourcing will occur when the firm is weak in the other type of human capital.⁴

HYPOTHESIS 3 (H3). *The marginal impact of higher firm-specific or industry-specific human capital on the tendency of firms to internalize knowledge work is highest when the other type of human capital (firm specific or industry specific) is low.*

Occupational Human Capital

As noted earlier, occupational HC refers to knowledge and skills relating to a profession or field of knowledge (e.g., law, accounting, software engineering) and is the most widely applicable of our three types of HC because it applies across a variety of industry settings. Two key issues must be addressed to understand how occupational HC impacts the sourcing decision for a given knowledge project: (1) whether the (client) firm is likely to have a higher level of occupational HC versus specialized suppliers and (2) the extent to which occupational HC is needed to complete a particular task.

There are important differences between intrafirm functional departments of companies (e.g., the legal department within a semiconductor company) and suppliers who specialize in an activity (e.g., an intellectual property law firm) in how they manage and incentivize talented individuals to accumulate human capital. Specialized suppliers may have a particular advantage in (and motivation for) developing superior occupational HC by virtue of their differential ability to attract, motivate, and retain knowledge workers. The suppliers' labor market advantage is driven in part by their ability to provide a highly incentivized work environment, which attracts talented employees and rewards them for developing high levels of occupational HC. Because superior occupational HC can in turn be employed to service the needs of multiple clients, it becomes a fundamental value proposition for some supplier firms, who in turn create highly targeted incentives and a strong selection environment for occupational experts within their organizations. Talented individuals are also drawn to these suppliers for professional development, which stems from the variety of occupationally interesting and challenging work they offer, and opportunities to work and learn alongside occupational experts. Although suppliers must bear the costs of coordination with client firms, these costs can be offset by the premium they receive for their expertise, some of which is passed on through incentivized pay and professional development to their employees.

Intrafirm departments, in contrast, trade on their knowledge about the processes, technologies, and strategies *specific* to the firm (firm-specific HC), and consequently, they tend to engage in a narrower range of

activities than external suppliers. As a result, intrafirm departments are unable to reproduce supplier incentive structures for the development of occupational HC. Client firms can try to attract and motivate talented employees by promising them interesting work as well as high pay, but they may be unable to fulfill such commitments because they face inherent difficulties in creating a market-like environment for their employees, in part because unlike specialized suppliers they do not have to compete for work from external clients. In other words, focal firms are at least partly handicapped in their development of occupational HC because of the well-known challenges posed by selective intervention within firms (Williamson 1985, Foss 2003). Thus, the two core issues are that the firm cannot replicate supplier incentives for employees to be experts in their occupation and that the range of projects (and occupational HC development opportunities) within any one firm is inherently limited by the scope of the firm.

An example from our empirical context is patent attorneys. Internal patent attorneys are likely to stay current only in narrow aspects of the law that affect their employers' technologies (and may not have time even for that, as they deal with various firm-specific issues), whereas patent attorneys for a top law firm will be current in many aspects of patent law because of the learning opportunities they have and the incentives they face to win business and service clients. Specialized law firms may be disadvantaged relative to internal patent departments in their knowledge of the firm (firm-specific HC); however, they can compete with internal departments based on superior occupational (and potentially industry-specific) HC, which in turn can be developed through and applied in services provided to multiple client firms.

Thus, some specialized suppliers are likely to accumulate superior occupational HC and attract customers looking for such expertise, which leads to more expertise development. It is important to recognize that suppliers may not develop superior occupational HC under all conditions of knowledge work. Nor is it the case that all suppliers will be more expert than intrafirm functions. For example, many suppliers may get business (and firms may outsource to them) because of lower costs or scale economies, because of industry-specific HC, or to smooth out internal firm workloads. Moreover, even when suppliers have superior occupational HC, client firms may not always outsource because expert service is inherently expensive (as we note above) and potentially costly to coordinate across firm boundaries (Grant 1996; Kogut and Zander 1992, 1996; Somaya et al. 2007).

Acknowledging that (client) firms can access superior occupational HC through the market, the question then shifts to when such expertise is most likely to be required. We propose that the incentives to access external occupational HC are strongest when the negative consequences associated with errors in using

occupational HC are large or, equivalently, when there are significant perceived gains from using expert occupational human capital and therefore a willingness to pay for accessing this expertise.

One factor in particular that may increase the cost of errors (and thus the value of occupational HC) is the extent to which the project is in an arena with extensive competitive actions by rivals (what we refer to as a "highly contested" area). Competitive actions are "specific and detectable competitive move[s]...initiated by a firm to improve or defend its relative competitive position" (Chen et al. 1992, p. 440) and can take many forms including price cuts, new product introductions, and legal actions (Ferrier et al. 1999, Ketchen et al. 2004). Actions by rivals often threaten the competitive position of a firm by increasing the complexity of the environment in which the firm must execute key business-related tasks (Porter 1980). Thus, it is more challenging to execute knowledge-based activities in an environment that is highly contested because actions in such an area typically attract close scrutiny and strong reactions from active rivals.

For example, if a firm wishes to file a patent in an area that is highly contested—that is, the area has seen multiple patent lawsuits as rivals fight over their intellectual property claims—then it should expect the focal patent to also be challenged by competitors in multiple ways. Rivals are likely to seek to overturn the patent, either proactively or in response to the patenting firm's efforts to enforce the patent, reflecting the competitive back-and-forth between rival firms. Therefore, the occupational HC required to obtain such a patent is likely to be more demanding because the negative consequences associated with errors in execution (which can surface later in litigation and undermine the firm's intellectual property position) are likely to be very significant.

Therefore, in highly contested areas, firms will demand high levels of occupational HC, and specialized suppliers who possess such expertise may be especially valuable. So we predict that firms will be more likely to outsource in an area that is highly contested.

HYPOTHESIS 4 (H4). *Firms are more likely to outsource knowledge projects situated in areas that are highly contested (and thus rely heavily on occupational human capital).*

The reliance on external suppliers for knowledge work in areas that are highly contested (and therefore require superior occupational HC) may be impacted by the extent to which the firm has developed its own stock of occupational HC. One key factor that may impact the firm's development of superior occupational HC is the size of its internal staff with training and credentials in the focal occupation. A larger internal staff will clearly lead to a lower baseline level of outsourcing. The firm must utilize its staff, and, controlling for other factors,

it would outsource less. The main issue we address here is how that larger internal staff will differentially affect outsourcing when occupational HC is particularly important (e.g., in contested areas). We make the case that a large internal staff may enable the focal firm to offset some of the incentive and learning advantages of suppliers in developing occupational HC.

One potential advantage of a large internal staff is that the firm can organize its internal function more effectively as a knowledge hierarchy (Garicano 2000, Garicano and Rossi-Hansberg 2006), where some individuals specialize as occupational experts and leverage the talents of others for more mundane work. Although suppliers may be similarly organized, firms with larger internal staffs can also use knowledge hierarchies to narrow the occupational expertise gap with suppliers. Knowledge hierarchies have a number of incentive features that can help the firm attract and motivate talent. First, the firm's staff may value opportunities for promotion up the hierarchy, and experts at the top of the hierarchy may enjoy compensation that is more "market linked" than at other firms. Second, inexperienced talent may value the chance to work with and learn from these experts. Third, the experts themselves may be able to choose more interesting and challenging projects, which they intrinsically value. Finally, a large internal staff may also act as a signal to talent that the occupational area is important to the firm and will receive resources and training investments in the future.

Additionally, firms with large internal staffs (that are organized as knowledge hierarchies) may have a number of advantages for learning and expertise development within the firm. In addition to the within-firm learning imparted by occupational experts, the existence of significant occupational HC within the firm may increase its absorptive capacity for knowledge from its environment (Cohen and Levinthal 1990). For example, the firm's professionals may be better connected with outside experts, receive more information about new developments, and be better able to understand and assimilate this information. Such firms are also likely to have a wider scope of occupational activities, thus providing their staff with a richer variety of opportunities to learn and develop their occupational HC.

For all of these reasons, a firm with a large internal staff may be more able to develop occupational HC, which allows it to better handle the complexities associated with knowledge work in contested areas, thus decreasing the firm's proclivity to outsource these types of projects.

HYPOTHESIS 5 (H5). *The larger the firm's internal staff (in the focal occupational area), the weaker the (positive) effect of a project being in a highly contested area on the probability of outsourcing (i.e., the size of the firm's internal staff negatively moderates the effect of being in a highly contested area on outsourcing).*

Data and Variables

Sample

We tested our hypotheses by examining the patent outsourcing decisions of a sample of Fortune 500 firms in technology-based industries, in which firms were most likely to file and obtain patents, over the period 1990–1995. Our sample included all (129) public U.S. firms in the 1989 Fortune 500 survey (published in 1990) from the following five industries: chemicals (39 firms), computer manufacturing (22 firms), electronics (40 firms), pharmaceuticals (12 firms), and scientific and photographic equipment (16 firms). Using the *Directory of Corporate Affiliations*, we gathered information about the entire corporate family (all subsidiaries and divisions) for each firm in each year of our data set. We then matched these various corporate business units with the unique patent assignee codes used by the U.S. Patent and Trademark Office (USPTO) and obtained all patents filed by (or issued to) these firms during the period 1985–1995. In essence, we reproduced the approach adopted for the National Bureau of Economic Research patent data set (Hall et al. 2001), albeit at a more detailed year-by-year level for a smaller sample of large firms. Based on this approach, we developed a core sample of 80,129 patents filed over six years (1990–1995), although the complete data set (including prior years used to code some variables) has a little over 132,000 patents.

Our interest lies in studying the outsourcing of patent *prosecution*, which consists of activities related to filing and obtaining a patent from the USPTO. To identify whether or not a patent was outsourced, we used data from the front page of each patent in the "Attorney or Agent" field (see below). In addition, we employed multiple years of data on the universe of registered patent attorneys (from the Office of Enrollment and Discipline (OED) of the USPTO) to code the affiliation of patent attorneys (or agents) listed on the patent. Patent attorneys are highly specialized professionals who are required to have a technical background and pass the patent bar. Only registered patent attorneys may practice before the USPTO, and maintaining a current address with the OED is a requirement for registration. Additional data on each patent were collected and coded from various data sets made available by the USPTO.

Variables

The dependent variable in our analyses is an indicator variable, *outsourced*, which is coded as 1 if the "Attorney or Agent" field on the patent lists a law firm or external attorney and as 0 otherwise. In many patents, the focal company's attorneys are listed in this field, as identified from the OED attorney roster, so these patents were clearly not outsourced. In most outsourced patents, the "Attorney or Agent" field lists the name of a specific

law firm, usually without the names of attorneys who worked on the patent.⁵ In less than 10% of outsourced patents, the field lists attorneys employed by a law firm or in private practice, which we identified from the OED attorney roster. In approximately 12.7% of patents, the field is blank. We report results by dropping these latter patents from our sample, but we also estimated models by including these patents and coding them as not outsourced and obtained similar results.⁶ All coding of the *outsourced* variable was done by hand because it was straightforward to categorize entries in the “Attorney or Agent” field by visual inspection (but difficult to anticipate variations in names and spellings beforehand).

We measured relevant *firm-specific human capital* (Hypothesis 1) for a given patent prosecution project by the number of “backward” citations to patents of the same company that were also processed in-house. Because we expect diminishing returns in the accumulation of firm-specific HC, and because this variable (like others below) is highly skewed, we logged it. Reflecting our theoretical discussion, we seek to differentiate between situations in which relevant firm-specific HC is located within the firm’s internal staff through its prior work experience versus situations in which prior outsourcing (measured separately as a control variable; see below) may have prevented such HC development. We measure this variable over the five years prior to patent filing (see Endnote 4 regarding robustness to alternative measures).

We measured relevant *industry-specific human capital* (Hypothesis 2) by the company’s previous in-house experience in the technical domain of the focal patent. Because a patent is essentially a property claim in an area of technology, effective patent legal work requires knowledge about the patent’s technical domain, which is in effect a narrow area of industry-specific HC. Specifically, we measured the (logged) number of prior patents processed internally by the firm in the same primary seven-digit International Patent Classification (IPC) as the focal patent. The IPC has several advantages over U.S. Patent Classification (USPC), the most notable of which are the unambiguous technological basis for IPC classes and the nested nature of the IPC system (see Lerner 1995). The IPC ensures that each patent class maps to a narrow but coherent technological subfield (e.g., A61K 038/xx: Medicinal preparations containing peptides). We measured *industry-specific human capital* with patents applied for or issued over the previous five years (from the focal patent’s filing date) to account for the obsolescence of human capital over time and economize on the resource demands of coding. We reproduced our results using a four-digit level of IPC aggregation and a three-year capture period, giving us substantial confidence that our findings are not sensitive to these definitions.⁷

In Hypothesis 4, we propose that knowledge work situated in highly contested areas is likely to be outsourced to access the superior occupational HC of market suppliers. The ultimate goal of patent prosecution is to obtain a watertight intellectual property right with economically valuable scope, and both validity and scope are inevitably challenged if a patent ends up in litigation. At the time of patenting, patents that are in a contested domain marked by previous litigation are themselves likely to be viewed as being at risk of litigation. Among patents issued between 1990 and 2000, patents citing litigated patents are approximately 6.5 times as likely to be litigated as the average patent.⁸ Therefore, patents in such contested areas are particularly likely to be perceived as needing occupational expertise, which is corroborated by our interviews with company general counsels (see the Discussion section). Accordingly, we test H4 by using the dummy variable *highly contested area* (coded as 1 if the focal patent cited a patent that was litigated in the past). We collected data on patent litigation in U.S. district courts from the LitAlert database compiled by the USPTO and combined this with patent cases from the Section 337 forum of the International Trade Commission, which is an alternative forum for (import-related) patent disputes in the United States. We test Hypothesis 5 by interacting *highly contested area* with *internal staff size*, which measures the number of patent attorneys employed by the focal firm (coded from the OED roster).

In addition to these independent variables, we also coded a set of patent-level control variables. We focus on controls at the patent level because both interfirm cross-sectional variation and quarter-to-quarter intrafirm variation is already accounted for by our use of firm-quarter fixed effects (see below). Naturally, attributes of the patent play the biggest role in outsourcing differences among patents applied for by the same firm in the same quarter. For this reason, we also do not (indeed, cannot) include the main effect of *internal staff size*, which has no variation among patents filed within the same firm-quarter. We use *prior outsourcing in industry domain* to control for the (logged) number of same-IPC patents outsourced (over the previous five years) by the company. Note that this is the analog of our *industry-specific human capital* variable, except that these patents were outsourced rather than being processed internally. We also control for *prior related outsourcing*—the analog of our *firm-specific human capital* variable—which measures the (logged) number of self-cited patents outsourced to external service providers (over the previous five years).

Furthermore, we include the control variables *foreign inventor* (if the first listed inventor is based outside the United States), *number of patent claims* (the number of distinct patent claims listed on the patent), and *forward citations* (a logged count of citations to the focal

patent from subsequent patents) in our analyses. Because *forward citations* are truncated by the number of years of data available after the patent is issued, we face a potential bias in measuring this variable. Put simply, patents issued earlier will on average have more citations merely because they have had more time in which to be cited. We therefore obtain an unbiased estimate of *forward citations* (for 15 years from the issue date of each patent) by applying a correction factor from the citation function (versus time) for the average patent in each technology class (for more detail on this, see Hall et al. 2001). Finally, we code a set of six technology-grouping dummy variables using a USPC-based classification scheme widely used in prior research (Jaffe et al. 1998). Specifically, the groupings we use are *drugs and medical*, *chemicals*, *electrical and electronics*, *computers and communications*, and *other technologies* (with *mechanical* as the reference category).⁹

Analyses and Results

Each observation in our data is at the level of a patent, for which we need to model the dichotomous firm decision whether or not to outsource the legal patent prosecution work to an external supplier. Although our data set is longitudinal, spanning several years for each firm, it is not a panel data set of firm-year observations. Rather, because our companies typically filed for multiple patents in even a short time period (e.g., a three-month quarter), this provides a unique opportunity to account for all company-level factors (even ones that may vary from quarter to quarter) and focus only on the variation between patents filed by the same firm within the same quarter. Accordingly, we adopt a fixed effects model with firm-quarter fixed effects. Although both logit and probit approaches are well developed to model binary outcomes, the conditional fixed effects probit estimator is biased. Therefore, we employ the conditional fixed effects logit estimator to analyze our data, with robust standard errors clustered at the firm-quarter level (which ensures consistency in the standard error estimates).

The firm-quarter fixed effects model renders a very conservative test of our hypotheses because it accounts for both interfirm and within-firm (temporal) heterogeneity, and thus it rules out many alternative explanations. For example, any firm-level factor—such as financing, staffing, or strategy—that may affect outsourcing from quarter to quarter is accounted for, and the model essentially leverages the differences between patents filed by firms within the same quarter to estimate coefficients.¹⁰ This automatically means that we may lose some observations. For example, if a firm does not outsource any patents (or outsources all) in a given quarter, we cannot use data from this firm-quarter because idiosyncratic firm-level drivers of outsourcing in that quarter cannot

be separated from patent-level drivers. Consequently, an additional 13% of our observations drop out of the sample, leaving us with a final set of 59,590 observations.¹¹

Table 1 provides descriptive statistics of our data, split up by the subsamples of patents that are outsourced and internalized. Approximately 27% of patents in our sample are outsourced, and there is considerable variation, ranging from 0% in some firm-quarters to 100% in others. The 25th, 50th, and 75th percentiles of patents outsourced are, respectively, 4.6%, 28.6%, and 98.7% across all firm-quarters. The differences between the two subsamples in the means of our key independent variables are consistent with our hypotheses. The data also show substantial within unit (firm-quarter) variation, indicating that the patent-level differences are large. We report a correlation table (Table 2), which shows limited correlation across our key variables. In particular, the low correlation between firm- and industry-specific HC is reassuring, indicating that the empirical overlap between these two constructs is quite low.

Table 3 presents our main results from the firm-quarter fixed effects logit model. For ease of interpretation, the estimates are reported as odds ratios, with a null value of 1 (rather than 0). Model 1 in Table 3 shows that the control variable measuring the focal patent's foreign origin is significantly associated with internalization rather than outsourcing, consistent with a rationale that the associated patent work is more efficiently coordinated internally. The main effects of firm-specific (H1) and industry-specific (H2) HC are both supported at the 1% level of significance in Model 2. Hypothesis 3 predicted that firm-specific and industry-specific HC would have marginally diminishing interactive effects on firms' decisions not to outsource. The positive and significant interaction reported in Model 3 is consistent with the predictions of Hypothesis 3. Furthermore, our prediction in Hypothesis 4 that activities in highly contested areas are more likely to be outsourced is supported in Model 4, and Model 5 corroborates that this effect is negatively moderated by the size of the internal occupational staff within the firm, both at the 1% level of statistical significance. Finally, in the full model (Model 6), all of the aforementioned findings are again corroborated. Likelihood ratio tests also confirm large statistically significant improvements in model fit with each additional variable.

Interestingly, the relationships we find are not only statistically significant but the magnitudes are also quite large, indicating that they underpin economically meaningful findings. For example, based on Model 6, a one standard deviation increase in relevant firm-specific HC decreases the odds of outsourcing by 21.9% (Hypothesis 1). Similarly, a one standard deviation increase in industry-specific HC is associated with 40.7% lower odds of outsourcing (Hypothesis 2). Moreover, we find that *prior related outsourcing* and *prior outsourcing in industry domain*, the analogous variables that

Table 1 Descriptive Statistics of Key Variables

Variables	Measures	Not outsourced			Outsourced		
		Mean	Std. dev.	Within std. dev.	Mean	Std. dev.	Within std. dev.
<i>Firm-specific human capital</i> (H1)	(Log) No. of firm's own cited patents that were internalized	0.538	0.643	0.612	0.296	0.519	0.446
<i>Industry-specific human capital</i> (H2)	(Log) No. of internalized patents in same class	2.801	1.819	1.584	2.077	1.853	1.293
<i>Highly contested area</i> (H4)	Dummy = 1 if patent cites a litigated patent	0.126	0.332	0.320	0.151	0.358	0.337
<i>Internal staff size</i> (moderator for H5)	No. of patent attorneys employed by firm	62.95	42.56	(n/a)	55.96	59.09	(n/a)
<i>Forward citations</i>	(Log) No. of citations to focal patent (est.)	2.185	1.122	1.034	2.414	1.105	0.980
<i>Prior outsourcing in industry domain</i>	(Log) No. outsourced patents in same class	0.918	1.281	0.927	1.938	1.637	1.250
<i>Prior related outsourcing</i>	(Log) No. of own cited patents outsourced	0.049	0.208	0.192	0.227	0.437	0.403
<i>No. of patent claims</i>	(Log) No. of claims in focal patent	1.786	0.985	0.952	1.691	0.899	0.846
<i>Foreign inventor</i>	Dummy = 1 if first inventor is outside the United States	0.091	0.287	0.274	0.063	0.243	0.212
<i>Drugs and medical</i>	Technology group dummy variable	0.125	0.330	0.231	0.066	0.248	0.153
<i>Chemicals</i>	Technology group dummy variable	0.212	0.408	0.362	0.120	0.325	0.263
<i>Electrical and electronics</i>	Technology group dummy variable	0.273	0.445	0.399	0.294	0.456	0.404
<i>Computers and communications</i>	Technology group dummy variable	0.211	0.408	0.331	0.350	0.477	0.378
<i>Other technologies</i>	Technology group dummy variable	0.023	0.149	0.143	0.016	0.127	0.112
No. of observations			43,301			16,289	
No. of (firm-quarter) groups			1,242			1,242	

Table 2 Correlations Between Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 <i>Firm-specific human capital</i>	1													
2 <i>Industry-specific human capital</i>	0.29	1												
3 <i>Highly contested area</i>	0.02	-0.01	1											
4 <i>Internal staff size</i>	0.38	0.15	-0.02	1										
5 <i>Forward citations</i>	0.06	0.1	0.09	0.11	1									
6 <i>Prior outsourcing in industry domain</i>	0.04	0.49	0.03	0.25	0.2	1								
7 <i>Prior related outsourcing</i>	0.02	0	0.06	0.01	0.11	0.32	1							
8 <i>No. of patent claims</i>	0.02	-0.07	0.02	-0.02	0.05	-0.11	-0.02	1						
9 <i>Foreign inventor</i>	-0.05	0.05	-0.01	0.06	-0.05	0.02	-0.03	-0.01	1					
10 <i>Drugs and medical</i>	-0.01	0.08	0.1	-0.18	-0.06	-0.07	-0.06	0.14	0.05	1				
11 <i>Chemicals</i>	0.05	-0.14	-0.03	-0.07	-0.18	-0.18	-0.06	0.03	0.02	-0.17	1			
12 <i>Electrical and electronics</i>	-0.04	0.07	-0.08	0.01	0.03	0.01	-0.01	-0.08	-0.03	-0.22	-0.3	1		
13 <i>Computers and communications</i>	-0.01	0.16	0.06	0.24	0.24	0.34	0.12	-0.09	0	-0.2	-0.28	-0.36	1	
14 <i>Other technologies</i>	0.01	-0.04	0	-0.02	-0.04	-0.09	-0.03	0.03	-0.01	-0.06	-0.08	-0.1	-0.09	1

Table 3 (Firm-Quarter) Fixed Effects Logit Models for the Outsourcing of Patent Legal Work

	Dependent variable: <i>Probability of outsourcing</i>					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Firm-specific human capital</i>		0.720** (0.011)	0.711** (0.012)			0.712** (0.012)
<i>Industry-specific human capital</i>		0.726** (0.019)	0.655** (0.033)			0.654** (0.032)
<i>Firm-specific HC *</i>			1.033** (0.013)			1.034** (0.013)
<i>Industry-specific HC</i>						
<i>Highly contested area</i>				1.182** (0.052)	1.383** (0.085)	1.313** (0.080)
<i>Highly contested area * Internal staff size</i>					0.998** (0.001)	0.998* (0.001)
<i>Forward citations</i>	0.986 (0.015)	0.993 (0.015)	0.993 (0.015)	0.982 (0.014)	0.981 (0.014)	0.990 (0.015)
<i>Prior outsourcing in industry domain</i>	1.092** (0.017)	1.519** (0.034)	1.515** (0.033)	1.092** (0.017)	1.092** (0.017)	1.513** (0.033)
<i>Prior related outsourcing</i>	2.491** (0.177)	2.378** (0.154)	2.374** (0.154)	2.480** (0.175)	2.479** (0.176)	2.365** (0.154)
<i>No. of patent claims</i>	0.926* (0.029)	0.939* (0.029)	0.942+ (0.029)	0.927* (0.029)	0.926* (0.029)	0.942+ (0.029)
<i>Foreign inventor</i>	0.742** (0.075)	0.718** (0.071)	0.720** (0.071)	0.746** (0.075)	0.746** (0.075)	0.722** (0.072)
<i>Drugs and medical</i>	1.097 (0.108)	1.301** (0.116)	1.306** (0.117)	1.085 (0.106)	1.083 (0.106)	1.288** (0.115)
<i>Chemicals</i>	0.779** (0.045)	0.801** (0.044)	0.802** (0.044)	0.779** (0.045)	0.778** (0.045)	0.800** (0.044)
<i>Electrical and electronics</i>	1.002 (0.056)	1.104+ (0.061)	1.106+ (0.061)	1.002 (0.056)	1.001 (0.056)	1.104+ (0.061)
<i>Computers and communications</i>	0.828* (0.061)	0.966 (0.066)	0.965 (0.066)	0.819** (0.060)	0.824** (0.060)	0.958 (0.065)
<i>Other technologies</i>	0.772* (0.082)	0.821+ (0.084)	0.818* (0.084)	0.768* (0.082)	0.766* (0.082)	0.813* (0.083)
No. of observations	59,590	59,590	59,590	59,590	59,590	59,590
No. of (firm-quarter) groups	1,242	1,242	1,242	1,242	1,242	1,242
Log likelihood	-20,899.15	-20,337.08	-20,332.99	-20,888.03	-20,881.68	-20,320.56

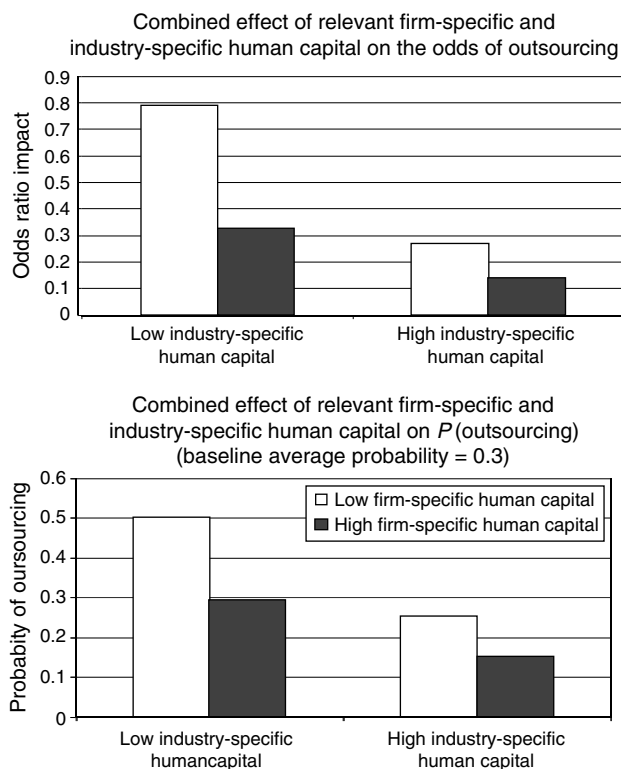
Notes. Robust clustered (by firm-quarter) standard errors are in parentheses. Estimates reported are exponentiated coefficients (odds ratios); thus, values above (below) 1 indicate a higher (lower) probability of outsourcing.

+Significant at the 10% level; * significant at the 5% level; **significant at the 1% level.

measure prior outsourcing rather than internalization, were associated with statistically significant (1% level) *increases*—as opposed to decreases—in the odds of outsourcing. In other words, it is not just the firm’s prior projects within the same firm-specific context or industry domain that matters but the extent to which the relevant human capital was developed internally by keeping the prior projects in-house. The impact of patents being in highly contested areas is also quite large; Model 6 indicates that this increases the odds of outsourcing by 31.3% (for a firm with an internal staff size of zero patent attorneys). At a more reasonable internal staff size of 14 (mean minus one standard deviation for this variable), a patent in a highly contested area still has approximately 28.2% higher odds of outsourcing.

We now turn our attention to interpreting the interaction effects that we estimate. Interpreting the mag-

nitude and direction of change implied by interaction terms can be tricky in choice models because of the nonlinear character of these models (Huang and Shields 2000). Therefore, we follow recommended best practice (Hoetker 2007) and evaluate the joint impact of interaction variables at representative high and low values from our data (see Figures 1 and 2). The chosen values of the variables are mentioned in the notes accompanying the figures. In each figure, there are two sets of graphs, one representing the estimated impact in terms of odds ratios and the other in terms of probabilities.¹² Consistent with Hypothesis 3, Figure 1 shows that the marginal impact of an increase in firm- or industry-specific HC on outsourcing is greatest when the level of the other type of HC (industry specific or firm specific) is low. For example, an increase in firm-specific HC from low to high levels is associated with a 58.6% drop in the odds of

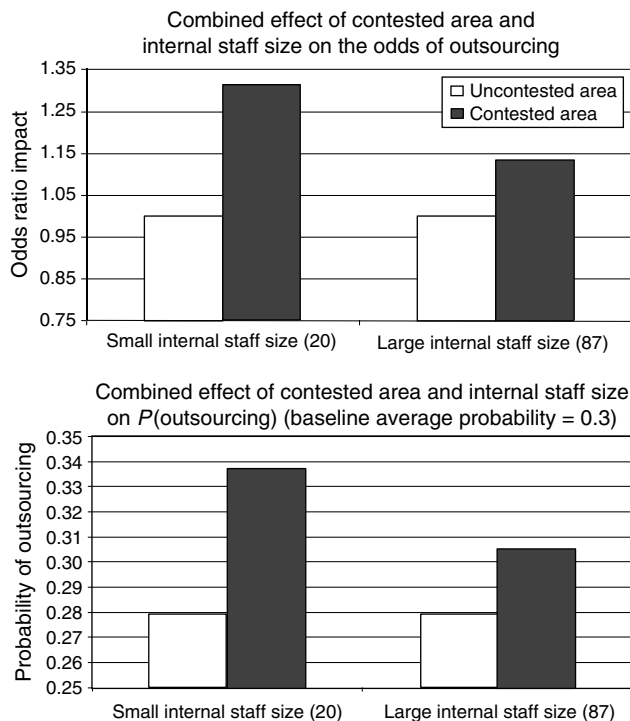
Figure 1 Interactive Effects of Relevant Firm-Specific and Industry-Specific Human Capital on Outsourcing

Note. For both *firm-specific human capital* and *industry-specific human capital*, we use the 25th and 75th percentiles of the variables as the low and high values, respectively.

outsourcing when industry-specific HC is low but only a 47.9% when it is high. Figure 2 shows that the positive impact of highly contested areas on the probability of outsourcing is diminished in firms with larger internal staff. Based on the coefficient estimates, we infer that when a firm has a staff comprising 161 patent attorneys, the tendency to outsource patent prosecution in highly contested areas is completely nullified. In our sample, the largest internal staff size is 159 attorneys (for IBM), which indicates that the impact of highly contested areas is essentially zero for the largest firms in our sample.

Discussion

In this paper, we have developed a human capital-centered framework of capability development and sourcing decisions in knowledge work. We highlight the value of examining the governance of related (but distinctly separate) transactions of the firm and how they influence the focal sourcing decision through their implications for capability development. To this end, we extend Castanias and Helfat's (1991, 2001) framework of firm-specific, industry-specific, and general human capital by focusing on occupational HC as a type of general HC that is particularly relevant to the performance

Figure 2 Combined Effects of Highly Contested Area and Internal Staff Size on Outsourcing

Note. For *internal staff size*, we use the 25th and 75th percentiles of the variable as the low and high values, respectively.

of knowledge work. Although occupational HC is specific to a particular profession (e.g., law, accounting), it is characteristic of general HC because it still crosses firm and (applied) industry boundaries.

Employing the framework of firm-specific, industry-specific, and occupational HC, we examine the impacts of two main governance choices on HC-based capability development, which in turn influence the focal sourcing decision. First, with respect to firm-specific and industry-specific human capital, we advance a path-dependent logic whereby prior sourcing decisions affect HC development (either at the firm or its suppliers) and thus influence future sourcing decisions. In so doing, we build on Argyres and Liebeskind's (1999) ideas about intertemporal "governance inseparabilities" between transactions and explore how the origins of firm capabilities—which affect current outsourcing—are rooted in the governance choices of prior related transactions (Argyres and Zenger 2012). Inter alia, our research underscores prior research findings that outsourcing can decrease organizational learning (Reitzig and Wagner 2010) and create excessive dependence on suppliers (Ring and Van de Ven 1994, Langlois and Robertson 1995). Put differently, we take a dynamic approach to argue that past sourcing decisions may have lasting effects on firm learning and capabilities, which then impacts future sourcing decisions. In this way, our research responds directly to

Williamson's (1999, p. 1104) observation that "a predictive theory of economic organization will be enriched by making more prominent provision for the many ways in which learning influences the intertemporal governance choice calculus."

Second, we argue that there are systematic differences between (client) firms and suppliers in how they govern the employment relationship with skilled employees, and these differences impact the development of certain types of HC-based capabilities. Whereas client firms have an advantage in developing firm-specific HC, suppliers have an advantage in developing occupational HC because of their employees' incentive structures and scope of work. Drawing on the TCE logic regarding selective intervention (Foss 2003, Williamson 1985), we make the case that it is difficult for client firms to recreate the incentive structures and learning opportunities present in supplier firms with respect to occupational HC. The resulting differences in firm capabilities can set in motion a virtuous cycle of outsourcing to suppliers and development of their occupational expertise.

Our empirical analyses of patent outsourcing decisions produced several key findings, which we discuss below. To reinforce and complement these findings, we draw on unstructured field interviews with retired general counsels from six different firms in our sample. The interviewees were asked to explain when and why they outsourced patent prosecution work in their companies. In two cases, the general counsels referred us to their chief patent counsels, and for those companies, our interview responses below reflect primarily the opinion of the latter. Six of these executives had built their careers as patent law professionals, and all eight had direct experience in administering and supervising the patent law function at their companies during the 1990s. We conducted these interviews at the beginning of our research and revisited the transcripts after conducting the empirical analyses.

Firm-Specific Human Capital

One important finding of our research is that a knowledge project is less likely to be outsourced when it requires higher levels of firm-specific HC, and this human capital has been developed within the firm through the internalization of prior related projects. Both TCE and KBV would argue that the need for firm-specific HC should decrease the probability of outsourcing; however, we develop the logic and empirical tests to show that this is only true when prior related projects of the firm are also internalized. We find in our analyses that firms are actually more likely to outsource the focal activity if prior related projects were outsourced, thus giving suppliers the opportunity to build firm-specific HC instead of the focal (client) firm. Our interviewees noted a number of potential obstacles to

outsourcing projects that are more firm specific, including the transaction costs of sharing such knowledge, the communication barriers across organizational boundaries, and potential appropriability concerns. Although none of our interviewees (labeled anonymously A–F for each company/interviewee) specifically highlighted the need for internal firm-specific HC, their comments appear to assume that such human capital would be available in-house:

[T]o educate them from the beginning the concept of what you do and the prior art and all the rest of the kinds of things...to get somebody to come in and do that from the outside...it's very expensive, to just come in and learn without having to...you know...produce. (A)

If they have to contract out then there is another relationship that has to be worked out, and that's between inside attorneys and outside attorneys, and that tends to breed some barrier...you don't want your clients [firm R&D] to be talking to these outside guys and not talking with you...and so on. (A)

[O]ur [internal] patent attorneys are more efficient because they know the client and they know the product, and they don't have to learn things on a new job. (E)

In the high-tech business...if it is [the company]'s business, for example, it's also going to be somebody else's business...because you know who your competitors are [acknowledges potential for knowledge leakage and conflict of interest]... Usually, we would try to keep the most important patent applications in-house. Because they often called for a lot of back-and-forth between the engineers and the patent lawyers...and the business people... (F)

Industry-Specific Human Capital

Our results also show that outsourcing decisions are influenced by how firms develop their HC in various industry-specific domains. In particular, internalizing prior patent prosecution projects in an industry (technology) domain contributes to the firm's industry-specific human capital and thus reduces the probability of outsourcing future projects in the same domain. Conversely, our results also show that if a firm outsources prior patent prosecution projects in an industry domain, it may suffer from an "incompetence trap," whereby suppliers develop and maintain an industry-specific HC advantage relative to the firm. Thus, initial decisions to outsource (or not) may spawn trajectories over time that create heterogeneous capabilities between firms and their suppliers. Consistent with the resource-based view, these heterogeneous capabilities would not be sustainable without effective barriers to imitation (Barney 1991, Wernerfelt 1984), which in this case may be provided by the costs of learning by doing and time compression diseconomies in catching up with the knowledge frontier (Dierickx and Cool 1989). Two of our interviewees in particular highlighted the role played by industry-specific HC in outsourcing decisions:

[We outsourced]...if it was in an area where we felt we needed the [industry domain] expertise that we did not have in house. Initially, we didn't have patent attorneys with a biotechnology background—it was a new area. We recognized very rapidly that we needed someone [a patent attorney] that had that biotech background to work in that area. [Question: *So you recruited someone?*] We recruited someone, but initially we went outside to do the work. (B)

So you may find in a large company that half the patent application work is being sent to outside counsel, who in turn are people who are specialists in their technological fields and they can write patent applications efficiently because...presumably, if they really worked in the same area for a long time, they really know the subject matter... (F)

Oftentimes, if there is [industry domain] expertise in a particular area in a law firm it will likely spread from one attorney to another and so on. So there might be a group of folks who are pretty good in a certain technology. So that might come about if, say, business increases from a particular corporate client. (F)

Taken together, we believe our findings provide compelling initial evidence that the outsourcing of knowledge work is not a static process but is instead shaped by the dynamic path-dependent development of firm- and industry-specific HC resulting from prior outsourcing decisions (Argyres and Zenger 2012). Furthermore, consistent with KBV theories (Kogut and Zander 1992, 1996; Conner and Prahalad 1996; Nickerson and Zenger 2004), our results show that firms have an organizational advantage in coordinating knowledge activities within their boundaries. The effectiveness of knowledge coordination within the firm has the effect of amplifying the advantages internal departments enjoy relative to external suppliers when they have strengths in at least one type of HC. Accordingly, we find that the marginal effect of either firm-specific or industry-specific human capital on sourcing decisions is greatest when the other is low. Although we did not ask our interviewees directly about these differences in coordination, one interviewee (B) noted that sometimes there “wasn't any time saving at all” (for internal staff) from outsourcing because of all the additional coordination involved. Thus, one critical factor diminishing the attractiveness of outsourcing in knowledge work is the amount of firm-supplier coordination that is sometimes needed.

Occupational Human Capital

We also found significant support for our hypothesis that firms prefer to outsource knowledge work in highly contested areas to access the potentially superior occupational HC of external suppliers. We theorized that suppliers accumulate superior occupational HC on account of their ability to incentivize occupational experts and provide occupational learning opportunities, both of which attract and motivate talented employees.

Outsourcing to external suppliers is of course costly, both in the organizational costs of coordinating with them and in the pecuniary costs of paying for their expert service. Although our interviewees noted these costs, they also acknowledged the value of law firm occupational expertise. Consistent with our empirical results, a number of our interviewees explained that this expertise is an important driver of outsourcing decisions for patents that are likely to be litigated:

[You outsource]...if you have a special situation...oh, I don't know, something related to litigated matters or something related to you are in litigation, and you are in development within the scope of litigation...in general, I think it works much better inside [the company]. (A)

The reason you don't go out to an outside patent firm unless you absolutely have to is because it's too expensive. The patent lawyers, I mean they're just voracious! Have you talked to patent lawyers? They're absolutely horrible. They're so expensive. There are few of them, their skills are much in demand, and the good firms are really very good, and then they price accordingly... You do as much in house as you can. It's cost effective. (B)

[I]t's all based on the speculation that you may be sued or may wish to sue. And in that circumstance, why, of course you go out, you hire the best you could and you pay the fees, and you're happy that those people are available to work for you, and are willing to. (B)

Well, that is a way to do it, is to have an outside law firm, but that's a more expensive way to do it... In terms of long-range factors that is not the most economic way to go. (C)

[G]enerally, patent attorneys in-house can be retained at a lower cost per task...we're not carrying the burden of marketing and some of the productivity and cost effectiveness shortfalls the law firms have, and we can produce in-house cheaper because of that... (E)

That having been said, you go outside...for expertise... There are certain things that are at a high enough level of importance that you want to pay the extra buck to get the best there is...[because] you lose a lot of other revenue if you get beat [in litigation], you may go outside just to cover yourself, to only get the best... It would be legal expertise, it would be someone who had been there before. (E)

Thus our empirical findings and qualitative interviews both suggest that, because of the need for superior occupational HC, outsourcing is likely when the focal activity is in a highly contested area. Drawing on research in knowledge hierarchies (Garicano 2000, Garicano and Rossi-Hansberg 2006) and absorptive capacity (Cohen and Levinthal 1990), we hypothesized that firms with large internal staffs may be able to narrow the occupational HC gap with leading suppliers. Our empirical findings corroborate that the higher probability of outsourcing in highly contested areas is negatively moderated by internal staff size.

Limitations and Future Research

Although our research provides valuable insights into outsourcing in knowledge-based activities, it is not without limitations, which may also provide valuable opportunities for future research. Let us begin by noting some characteristics of patent legal work, which may limit the generalizability of our empirical findings to other types of knowledge work. First, patents are usually prosecuted by individuals or small (two- to three-person) teams, and the final work product falls wholly within a single profession (patent law), so there are few challenges of managing large teams of individuals, especially cross-functional teams. Second, patent work is an important support activity and perhaps a valuable complementary capability for technology firms, but it is different from more strategic knowledge-based activities such as, say, R&D or marketing. Third, there is a vibrant market for patent legal services arising from demand outside the focal firms in our study, which is also the case with many other types of knowledge work (e.g., IT, human resource management), but not always so. Moreover, our study focuses only on large Fortune 500 firms, and small or start-up organizations may face very different resource constraints and competitive pressures, which may in turn impact their outsourcing decisions. Thus, future research can build on our work by examining the extent to which our findings apply to a range of other empirical settings. Finally, our research adopts a simple dichotomous approach by treating any project as outsourced if a supplier was involved in it and internalized if not. In theory, a number of intermediate solutions are also feasible that involve various degrees of buyer–supplier coproduction (but are less discernibly prevalent in our context; see Endnote 5), which is also a potential topic of interest for future research.

Our findings help explain how capabilities may develop as a result of prior sourcing choices that give firms the opportunity to develop firm- and industry-specific HC that improves their relative capabilities for future transactions. However, plausible alternative explanations may arise if these prior human capital development opportunities are also correlated with transaction costs or other drivers of internalization in the related future projects. Moreover, we need to understand more deeply the mechanisms by which firms maximize the learning (and thus capability development) potential of these opportunities to accumulate certain types of human capital. Furthermore, although our study focuses on how prior sourcing choices influence current sourcing decisions, the decision to outsource or not may also anticipate future needs in certain areas (e.g., in specific industry domains) and include the firm's choice to commit resources into these areas. We should note that client firms may sometimes be amenable to having suppliers who develop and maintain the needed firm- and industry-specific HC and thus provide them with a high level of

service. Our interviews also highlight a potential role for strategic firm actions to break out of incompetence traps (e.g., the hiring of patent attorneys) or supplier actions to lure firms into one. Thus, we have highlighted a number of areas in which our understanding of capability development through prior governance choices is limited, and a broader investigation of these questions awaits future research.

With respect to occupational HC development, we built our arguments by relying on the differences between (client) firms and suppliers in their governance of employees and in the learning experiences they provide. However, there may be limits to these mutually reinforcing mechanisms, and understanding how and when such limits operate can contribute significantly to our understanding of the evolution of vertical boundaries in industries (Jacobides and Winter 2005). Furthermore, occupational HC may be important for knowledge projects in many other contexts besides highly contested areas, thus requiring outsourcing to expert suppliers. For example, the activity in question may involve a very complex problem (e.g., a difficult strategic dilemma is often referred to a management consulting firm), or the cost of even small mistakes may be very high (e.g., a mission-critical IT system is often outsourced to a leading IT services firm). Future work can examine other kinds of business problems that cannot be solved with straightforward applications of occupational HC and so require the expertise of specialized suppliers. Future research can also study the extent to which outsourcing to a particular supplier may influence future outcomes through signaling or other mechanisms. For example, does outsourcing to a particular attorney or law firm act as a signal that affects future patent citation or litigation?

Given that knowledge is substantially embedded within the human capital of individuals (Felin and Hesterly 2007), another useful extension of our research is to understand how the mobility of knowledge workers influences the ability of firms to develop, utilize, and retain the human capital needed for knowledge work. Firms experiencing high employee mobility may find it difficult to retain critical HC, and they may seek to develop routines and structures to share and embed knowledge organizationally. Conversely, employee mobility may allow firms to acquire individuals with certain expertise and reinforce meritocratic selection mechanisms that lead to HC development. We conducted a preliminary investigation of this issue by estimating our models with subsamples of our data that had high (above median) and low (below median) mobility, but we found no statistical differences. Mobility from (all) suppliers to client firms is rare in our sample, averaging at approximately 0.5 attorneys per firm-year, which may explain why our results hold despite such mobility. In general, understanding

the boundary conditions created for knowledge acquisition and retention by the mobility of talented knowledge workers across firm boundaries is a promising area for future work.

Conclusion

Overall, our findings suggest that organizations should carefully consider the long-term effects of their outsourcing decisions on the development of human capital—learning will accrue to either the firm or a supplier, which will influence the firm's future capabilities relative to suppliers for similar types of projects. These longer-term implications for human capital development need to be considered in conjunction with the short-term cost–benefit analysis for the project to fully address the implications for sustainable competitive advantage. At the same time, we find a distinct organizational disadvantage for firms in developing occupational human capital relative to their specialized suppliers. The disadvantage stems from differences in governing and incentivizing skilled employees, which can be partially offset by a large internal occupational staff that seeks to replicate some governance features of supplier organizations.

In conclusion, we have highlighted the role of a firm's governance choices as not only a transaction-cost-minimizing effort but a building block for the firm's stock of human capital and, ultimately, capabilities. We built on extant typologies of human capital to focus on three types of human capital that are central to knowledge work—firm specific, industry specific, and occupational—each of which poses different challenges for firms' capability development and sourcing choices. As our economy transitions into one that increasingly relies on knowledge, this emerging understanding of the nexus between capability and governance issues entailed in knowledge work will likely have important implications for firm strategy, the careers of knowledge workers, the evolution of industry boundaries, and the theory of the firm.

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Endnotes

¹Assuming a conservative definition of knowledge-based services as "NAICS 54: Professional, scientific, and technical services," this sector was about two-thirds (66.4%) the size of manufacturing in 2008 in value added (see http://www.bea.gov/industry/gdpyind_data.htm; accessed June 4, 2010).

²These HC types have been slightly elaborated in subsequent work to include "related industry" HC (Castanias and Helfat 2001); however, we base our approach on the original three types.

³We focus on the breadth of firm- and industry-specific HC, but arguably, the occupational HC needed for a project may also sometimes be narrow (e.g., JAVA coding as opposed to software engineering). However, our empirical context of patent law is already quite narrow in occupational terms, so we gloss over this nuance.

⁴To illustrate our logic, consider the following example. When a firm is low in both firm- and industry-specific HC, the probability of outsourcing may be 80%, but if the firm develops a high level of firm-specific or industry-specific HC, the probability of outsourcing may drop to 35%. Then if the firm moves from having a high level of just one type of HC (firm specific or industry specific) to having high levels of both types of HC, the probability of outsourcing may drop further to 10%. The key insight is that the biggest marginal effect occurs when going from being low in both types of HC to having high levels of one type of HC.

⁵We validated these data by comparing them with the firm or attorney responsible for 100 outsourced patents according to the Patent Application Information Retrieval (PAIR) database of the USPTO. The PAIR database records the attorney(s) or firm/office that currently holds the legal power of attorney to represent the inventor at the patent office. We found that the PAIR data match the "Attorney or Agent" data in 90 of 100 patents we examined. In nine other cases, the differences in the data plausibly result from a new power of attorney or change in patent ownership post grant. The discrepancy with one patent remains unexplained. Thus, the law firm or attorney(s) listed in the "Attorney or Agent" field appear to be responsible for patent prosecution in most patents. Our interviews suggest that the firm's own attorneys are also typically involved as boundary spanners, but we do not have a reliable way to measure any additional involvement. However, because the PAIR data indicate that a law firm listed on the patent is typically responsible for it, we conclude that the law firm is likely doing much of the heavy lifting on the patent.

⁶We investigated a sample of 100 such "blank" patents in the USPTO's PAIR database and found that these patents were about as likely to be outsourced (27%) as the average patent in our sample. Because not outsourcing is the higher-probability

event in our sample, we conducted the sensitivity analysis by coding “blank” patents in that category. Additionally, approximately 4.5% of patents have both external and internal attorneys listed on them. Our reported results reflect our judgment that the internal attorneys likely acted as exchange managers, but our results are also robust to the recoding of these patents as not outsourced (similar magnitudes, same significance levels).⁷ The five-year and three-year capture periods produce similar results for all variables, and the additional effects on outsourcing from human capital accumulated in the fourth and fifth years was insignificant. Therefore it appears that there may be diminishing returns to older knowledge. We also found that the additional marginal effect of domain knowledge in the broader four-digit IPC class (in addition to the narrower seven-digit IPC class) was quite small, albeit significant. Therefore, the levels of aggregation we have chosen appear to be reasonable, both in terms of patent classes and prior years of experience, and moreover, they are robust to changes in specification.

⁸Although there is some variation by technology sector—from 4.5 times to 8.5 times—the overall pattern is consistent across all technologies.

⁹In unreported models, we included the (logged) number of claims in the patent, the (logged) number of backward citations, and dummy variables for patents in technological domains (seven-digit IPC classes) with no prior patenting by the firm and for patents that contained no self-citations. Our reported results are robust to the inclusion of these additional variables.

¹⁰Our findings are robust to the use of firm fixed effects with time-varying firm-level controls and year dummies. However, statistical support for Hypothesis 5 slips below conventional levels in these models, which is not entirely surprising because the comparison group for an outsourced patent is now changed to all the patents filed by the firm in *any* time frame (and thus subject to much greater variation in unobserved firm-level heterogeneity).

¹¹The 13% of the sample that was dropped either had all patents outsourced or all patents processed internally for that particular firm-quarter. A very large number of firms (111) had at least one quarter with either all patents outsourced or all internalized. If these quarters coincided with (unobservable) firm-level changes in strategy that simply happen to be correlated with our key variables, our methods essentially prevented them from conflating our findings. Therefore, our firm-quarter fixed effects are particularly good at controlling for time-varying *within-firm* heterogeneities, which would be a primary concern with *firm-level* fixed effects models. These dropped data are spread out more or less evenly over the six years of our sample, with 15%–20% of dropped observations appearing in any given year.

¹²In logit models, the effect of a change in a variable on the probability (but not odds) of choosing an alternative depends on the values of the other variables, or equivalently, on the baseline probability estimated from the other variables. In the graphs that show the joint impact of variables on the probability of outsourcing, we choose the baseline probability such that the average probability across the combination of the interacted values is 0.3 (which is about that of the sample on average). It should also be noted that, unlike in regression models (or for odds ratios), the estimated probabilities at intermediate values of the variables do not simply lie on the straight lines connecting the high and low levels in the bar charts. Rather, the relationship is curvilinear.

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