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PROTECTION MYOPIA: MANAGERIAL VIEWS TOWARDS INTELLECTUAL PROPERTY AND THE IMPLICATIONS FOR INNOVATIVE PERFORMANCE

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Abstract

The strategies firms use to protect their intellectual property and knowledge can strongly influence their ability to capture the benefits of their innovative efforts. Using the attention-based theory, we explore positive and negative sides of legal appropriability. While asserting the benefits from having an orientation towards legal appropriability, we conjecture that protection myopia may lead some firms to allocate too much attention to legal appropriability, in particular when the behavioral and structural contingencies are unfavorable. Examining a panel of three successive waves of a large-scale survey data of UK manufacturing firms, we find that an orientation towards legal appropriability is curvilinearly (taking an inverted U-shape) related to innovative performance. However, this effect is only present when the firms' product innovations are radical or when they are involved in significant product improvements, and/or when their industries are low-tech.

PROTECTION MYOPIA: MANAGERIAL VIEWS TOWARDS INTELLECTUAL PROPERTY AND THE IMPLICATIONS FOR INNOVATIVE PERFORMANCE

The ability to appropriate or capture the benefits of an innovation is a central element in gaining and sustaining competitive advantage. Many innovators have been forced out of markets because of their inability to appropriate the benefits of their innovative efforts. Firms can use a variety of mechanisms to protect their innovations, ranging from patents to trademarks. Accordingly, strategies for protecting knowledge have become a central part of the development of an innovative strategy (Rivette and Kline 2000). Although managerial appropriability strategies have been found to be an important source of performance heterogeneity (Teece 2002; Colombo 2003; Dushnitsky and Lenox 2005), the benefits and costs of using of legal appropriability strategies for firms' innovative performance has received only modest attention.

To explore this question, the current literature on appropriability remains deficient in several important ways. First, attempts to understand how appropriability strategy shapes innovation have tended to focus on the industry level, and targeted primarily at policy makers (Levin et al. 1987; Cohen et al. 2000), often conflating managerial strategies towards appropriability with the appropriability regime those organizations operate within. In this sense, it is not clear what the scope is for managerial action to use protection mechanisms to gain competitive advantage over firms operating under the same appropriability regime. Secondly, where firm-level studies exist,

they focus almost exclusively on patents as the method of appropriation (see for instance, Rivette and Kline 2000; Arora et al. 2001; Ziedonis 2004; Dushnitsky and Lenox 2005; Ceccagnoli 2009; Reitzig and Puranam 2009). Yet, the empirical literature has shown that because innovations are typically complex and difficult to define completely and precisely, it is possible to invent around existing patent protections and, for firms that want to, to do so successfully and fairly quickly (Mansfield et al. 1981). Moreover, there are many industries where patents are a relatively uncommon means of protection. Thus, there is a need for managers to think about appropriability methods in a broader way, looking beyond patent protection (Teece 1986; Ettl and Reza 1992; McGaughey 2002). Thirdly, it has been suggested that firms should increase the emphasis on formal intellectual property (IP) protection to release the “hidden value” of their intellectual capital investments (Rivette and Kline 2000), suggesting that more is better when it comes to legal appropriability. This approach takes little account of the challenges of legal appropriability and the costs of this approach on managerial resources and attention.

Our paper seeks to address each of these limitations, helping to advance our understanding of how managerial choices about the nature of appropriability shape their chances of capturing returns from innovation. In doing so, we address the important question pertaining to what type of firms benefit from a focus on legal protection. To explore this question, our approach builds on the attention-based view of the firm (Simon 1947; Ocasio 1997; Ocasio 2011), with its focus on how managers divide their attention among different managerial challenges. Drawing from this perspective, we seek to address the three challenges identified above. First, we explore how firms’ relative focus on appropriability shapes innovative performance, helping to separate out the effects of industry-level appropriability regimes from firm-level decision-making. This approach helps to hone in on the implications of managers’ decisions to allocate more or less

attention to appropriability than managers in firms operating in the same industrial setting.

Secondly, we look at the broad range of legal mechanisms that firms may use to capture returns to innovation, breaking with the current literature focus on patents. Thirdly, we document the positive and negative effects of legal mechanisms, helping to gain an insight into how managerial attention may be misallocated or misaligned to external opportunities and threats. By adopting this perspective, we suggest that many organizations suffer from *protection myopia* which becomes manifest in under- or over-investments in managerial attention to legal protection mechanisms. However, we theoretically establish that under- or over-investments are less likely to occur when the behavioral and structural contingencies are favorable. In particular, we posit that protection myopia is less likely to occur, when the focal firm is collaborative, when the focal firms' innovations are incremental, and when the industry of the focal firm is high-tech.

THEORY AND HYPOTHESIS

Although capturing the benefits of innovations is difficult and for many innovators impossible, without the opportunity to capture some of the benefits of their efforts, there would be little incentive for firms to innovate. Innovation does appear to have considerable benefits for those firms able to achieve these changes to their products and processes. Evidence shows that innovators achieve higher profits, greater market value, better credit ratings and have a stronger chance of surviving in the market (Geroski et al. 1993; Hall 2000; Czarnitzki and Kraft 2004; Cefis and Marsili 2005). This suggests that although innovators may only be able to partially appropriate the value of their innovations, many firms are able to reap rewards from their innovative efforts.

In order to capture the benefits of innovations, firms appear to rely on a bundle of different

appropriability mechanisms, such as patents, design registrations and confidentiality agreements. However, no single mechanism can provide firms with security for their innovations (Arora 1997; Cohen et al. 2000). The combinations or bundles of appropriability mechanisms used by firms, make up what Cohen et al. (2000: 8) term an “appropriability strategy.” This suggests a considerable degree of managerial choice about whether and how to gain legal forms of appropriability and that such choice can be critical for business performance.

The use of legal appropriability mechanisms requires that firms expend considerable effort to render these instruments effective. Such efforts may create “attention allocation” problems, highlighted in the attention-based theory of the firm (Simon 1947; Ocasio 1997; Ocasio 2011). This theory states that managerial attention is a scarce and costly resource. The allocation of attention within the organization is dependent on its attention structures, which “collectively direct what, when and how organizations enact and respond to the environment” (Ocasio 1997: 196)..

In our setting, the allocation attention view suggests that there may be dangers to firms from under and over allocating managerial attention to legal mechanisms. In the case of the danger of under allocating attention to legal appropriability, Teece (1986) demonstrates that when an innovator firm lacks complementary assets (such as competitive manufacturing, distribution channels and complementary technologies), weak IP protection will most often lead imitators or holders of complementary assets to profit from an innovation at the expense of the innovator. Although focusing on legal appropriability is no guarantee of successful appropriation (Teece 1986: 287), this approach may be considered a necessary condition for the appropriation of innovative rents. Such a focus allows the firm to increase barriers to entry for potential competitors or imitators, thereby isolating the firm in its market space. Such efforts may also

allow the firm to increase the value of its existing assets by creating opportunities to enter the market for technology (Arora et al. 2001). Given the relatively limited use of formal IP protection in many industries, firms that can successfully gain access to and exploit legal mechanisms may be able to utilize competitive mechanisms which other firms may be unable or unwilling to use.

Why, then, might many firms under invest managerial attention in formal appropriability? First, although the cost of applying for legal mechanisms for protection may be relatively modest, the coordination costs on managerial attention can be high. To render this approach successful, managers will have to invest resources and attention to build their organization's legal appropriability capabilities through the creation of IP departments; using in-house or external legal experts; dedicating staff time to preparation, defense and enforcement of patents; and implementing strict rules of disclosure. Moreover, the organization has to police potential infringements and be willing to undertake legal efforts to enforce its IP. Second, the timing or likelihood of a firm capturing returns on these legal appropriability investments may be distant and uncertain, deterring risk adverse and short-term oriented managers from their use. For instance, a remedy for an innovator from an imitators' infraction is likely to materialize only several years after the transgression and after a costly legal case.¹ As such, only rarely can an innovator predict the value of its investments in formal mechanisms *ex ante*. Even the application process for obtaining formal IP is slow, with many years between the date of application and the granting of a patent. As a result of these factors, many managers turn away from formal IP by assuming that such measures are burdensome and unnecessary. Accordingly, those firms with an explicit orientation towards appropriating innovations are more likely to be

¹ An example of the time it can take to receive a remedy can be seen in the case of Robert Kearns, the inventor of the intermittent windshield wiper. It took Kearns over 20 years of legal action to reach a final settlement from Ford and other car manufacturers for their use of his invention.

able to capture the benefits of their innovations than those firms operating in the same industry that give lower levels of managerial attention to legal mechanisms.

Nevertheless, too strong an orientation towards legal appropriability may have negative performance implications. The high attendant costs of using legal appropriability may force managers to stretch their attention across wide and diverse areas of non-routine action, generally diluting their pool of attention. Therefore, those firms that invest time and effort in acquiring legal protection may have less time for the activities that may be essential for ensuring the success of their innovations in the market, such as mobilizing complementary assets. It should be stressed that the breadth of effort required for the firm to acquire legal protection is much greater than the effort and costs associated with having and/or purchasing legal expertise. Efforts devoted to legal protection may well affect the entire R&D organization in the sense that through all the stages of the innovative process it is necessary to pay attention to legal appropriability. Time spent on these efforts might divert the time and attention of key staff from science and engineering activities and from related collaboration with external actors. Indeed, Douglas Brotz, Principal Scientist of Adobe Software, at a public hearing on “The Use of the Patent System to Protect Software Related Inventions” (1994) suggested that:

[R]esources that could have been used to further innovation have been diverted to the patent problem. Engineers and scientists such as myself who could have been creating new software, instead are focusing on analyzing patents, applying for patents, and preparing defenses. Revenues are being sunk into legal costs instead of into research and development (quoted from Macdonald 2004: 152).

Similarly, Shane and Somaya (2007) found that patent litigation activities among US university technology transfer offices, in shifting the time and attention of key technical staff away from

activities such as the marketing of technologies and the establishment of licenses to litigation, had detrimental effects on technology transfer activities.

To characterize an under- or overemphasis on legal appropriability, we use the term *protection myopia* to capture the particular challenges related to the use of legal protection mechanisms. In sum, the above discussion leads us to conjecture that there are clear advantages to having a legal appropriability orientation for reaping the benefits of innovation, but that at some point, the focus becomes too strong, and the cost of appropriation begins to outweigh the benefits. Accordingly, we hypothesize that:

Hypothesis 1. A firm's orientation towards legal appropriability is curvilinearly (taking an inverted U-shape) related to its innovative performance.

The benefits of formal collaborations for innovation—when executed appropriately—are well recognized in the literature (see for instance, Mowery et al. 1996). However, formal collaboration may not only have direct performance implications; executing collaborative agreements on innovation related projects with a variety of external partners also shape the value of using legal mechanisms on innovative performance. We argue that external collaborations may help firms to partially overcome the protection myopia described above—both in terms of under- and over-emphasis on legal appropriability. We consider under- and over-emphasis in turn.

Firms engaging in a range of innovation-related collaborations are less likely to give too little attention to legal appropriability. This is because formal collaboration agreements related to innovation require knowledge of how to orchestrate a legal competence, either in-house and/or sourced externally (Ring 2002). Accordingly, experienced collaborators are likely to have built up routines and skills for operating in the “markets for technology”, enabling them to develop

collaborative arrangements in areas where information is uncertain and incomplete (Arora et al. 2001).

With a strong emphasis on legal appropriability, firms engaging in a wider range of innovation-related collaborations are less likely to suffer the negative consequences of a strong legal appropriability because firms whose formal collaborations span a diverse type of partners will have a compelling incentive to build capabilities in the use of legal mechanisms of protection because external collaboration can increase the risks of knowledge leakage (Arora 1995; Gans et al. 2002). This argument suggests a complementary relationship between external collaboration and the level of formal IP protection as holding formal IP may facilitate the exchange of knowledge assets. From this point of view, having a very strong orientation towards appropriability will have greater benefits (even if it is costly in terms of managerial attention) if the firm engages in formal innovation collaboration with different external partners, than if firm has no collaboration. In summary, we conjecture that innovation collaboration will affect both under- and overprotection:

Hypothesis 2. The relationship between a firm's orientation towards appropriability and innovation performance is moderated by innovation collaboration breadth, so that the inversely U-shaped relationship becomes weaker with greater levels of collaboration.

In the literature on innovation, considerable attention is focused on the degree of “radicalness” of the innovation and how this shapes organizational routines, business performance and market evolution. Although there are many competing definitions of radical innovation, most approaches stress the newness of the innovation, to the market and to the firm. This novelty reflects the degree to which new skills, knowledge and capabilities need to be developed by the firm in order to capture the commercial value of the innovation. Gatignon et al. (2002) define radical innovation as

advancing “the price/performance frontier by much more than the existing rate of progress”. In contrast, incremental innovations are defined as “those innovations that improve price/performance at a rate consistent with the current technological trajectory”.

In the case of a strong orientation towards legal appropriability, radical innovations may not develop because managers in the firm fail to mobilize the necessary complementary assets. Radical innovations often require significant changes in relationships between suppliers, customers and distributors of products. As such, managers need to place increased attention in building up support for these new products, often in the face of initially hostile reactions by related actors. This means that too strong an orientation on legal appropriability may distract managers from the more mundane challenges of winning acceptance for their new ideas in the market. In contrast, in the case of incremental innovations, the dangers of too excessive a focus on legal mechanisms will be less costly to organizations as they can access existing distribution channels and markets for their products. In effect, incremental innovations have lower attentional costs and so the effects of too much attention to legal appropriability on performance will be more modest in shaping the returns to innovation, than it will be for radical innovation. Given these arguments, we hypothesize that:

Hypothesis 3. The relationship between a firm’s orientation towards appropriability and innovation performance is positively moderated by the degree of novelty of the innovation, so that the inversely U-shaped relationship becomes stronger with greater levels of radicalness.

Industries associated with high levels of innovative intensity present a different set of managerial challenges for firms than industries that operate at a slower velocity (McCarthy et al. 2010). In our setting, these industry differences can have profound implications for the relative advantages firms can gain from using legal mechanisms of appropriability in their

innovative efforts. Traditionally, legal mechanisms of appropriability have been associated with industries with high levels of innovative investment. In theory, legal mechanisms provide a compensation mechanism for firms who spend considerable resources on innovation, increasing the likelihood they will be rewarded for their innovative efforts. This effect can be seen in surveys of appropriability, where a close relationship between technological opportunities of an industry—measuring using closeness to science and levels of investment in innovation—and the use of legal mechanisms of appropriability, has been detected (Levin et al. 1987; Cohen et al. 2000). In contrast, in low-technology industries—where technological opportunities are more modest, the benefits and costs of legal mechanisms may be less transparent.

In this context, we argue that an inverted U-shaped relationship between legal appropriability strategy and innovative performance is likely to be more significant in low-technology industries than high-technology industries. In particular, in high-technology industries, legal mechanisms are routine instruments that managers rely upon in their innovative strategy. Therefore, in order to keep up with other firms in the industry, most firms operating in these industrial environments need to avail themselves of these methods. As legal mechanisms are part of the “industrial recipe” (Spender 1989), there is less danger that managers will under or even over allocate attention to these mechanisms in their innovation strategy.

Finally, given many firms in low-tech industries under allocate attention to these mechanisms, managers that attend to these instruments may find that they can gain a competitive advantage from their use. By investing managerial resources and attention to legal mechanisms, managers in these contexts may be able to create more effective mechanisms to

help capture value from their innovative efforts than other more timid firms operating in same environment. However, the dangers of overly strong attention to legal mechanisms may also be stronger in low-technology industries rather than in high-technology industries. Indeed, managers in low-tech industries may reach out to legal mechanisms with unrealistic expectations about their potential value and, in doing so, they may find themselves caught out when these expectations are dashed by the slow and ineffective nature of legal protection. In contrast, managers in high-technology firms are less likely to fall prey to this myopia, as they are usually more experienced in their use and so have heightened awareness of their costs and benefits.

Therefore, we expect that the effects of under and overemphasis on legal mechanisms on innovation will be greater for low-technology industries than for high-technology industries.

Thus:

Hypothesis 4. The inverted U-shaped relationship between a firm's orientation towards appropriability and innovation performance will be stronger in industries characterized by low levels of innovative investment.

METHODS

Empirical Design and Sample

The data for the analysis is taken from the most recent three “waves” of the UK innovation survey (UK Community Innovation Surveys 2002-2004 (CIS4), 2004-2006 (CIS5), and 2006-2008 (CIS6), which are based on the Eurostat Community Innovation Survey (CIS) (Robson and Ortmans 2006; Robson and Haigh 2008; Robson and Kenchatt 2010). The basic definitions and types of questions suitable for innovation surveys are documented in the Oslo Manual, developed by the Organisation for Economic Co-operation and Development (OECD 2005). Since

innovation surveys are now collected on a systematic and on a semi-annual basis across a wide range of countries and sectors, they provide a rich store of information that complements and extends more traditional innovation indicators, such as patents. Although CIS data has been widely used in prior academic work, much of this research focuses on cross-sectional relationships. By using panel information, we hope to significantly extend the empirical literature that examines the determinants of the percentage of innovative sales (see, Mairesse and Mohnen 2002; He and Wong 2004; Cassiman and Veugelers 2006; Laursen and Salter 2006; Leiponen and Helfat 2010).

There were 16,445 firms providing valid responses to the CIS4 survey, 14,872 responses to the CIS5 and 14,281 to the CIS6, achieving a response rate of 58, 53 and 49 percent respectively. In constructing a panel dataset that covers the 7-year period from 2002-2008, we matched records for 6,575 firms that are common to both CIS4 and CIS5, and 6,933 firms common to both CIS5 and CIS6. Pooling all these records together, we constructed an unbalanced panel dataset across all three waves consisting of 23,223 observations in total, including 6,575 records from CIS4, 9,715 records from CIS5 and 6,933 records from CIS6². Given the lack of prior research on legal protection measures deployed in services, we choose to focus on the 7,019 observations (for 2,960 firms) in manufacturing sector only (i.e. circa 30% of the full sample). Using an IBDR reference number, we were able to link the CIS data with other ONS surveys. In particular, we draw on the Annual Business Inquiry (held in the Annual Respondents Dataset, i.e., the ARD)—the most comprehensive UK business survey—into our panel CIS dataset, providing information on additional firm-level characteristics such as foreign ownership, single or multiple products as well as industry-level characteristics, such as industrial diversification.

² In the case of a balanced panel dataset, our sample size would be limited to 11,379 observations only, given that there are only 3,793 firms common to all three waves of CIS data used here.

After removing unmatched cases we are left with a sample that includes information on 6,979 observations for our descriptive analysis. In our subsequent empirical modeling of innovation performance, all independent variables included are lagged by one time period; thus a further 3,428 observations were lost due to taking the lags or missing information on explanatory variables, resulting in 3,591 observations (for 2,568 firms) in our final estimation sample. We undertook a range of tests to ensure that this final sample used was representative of the respondent sample and found that on average our retained sample was slightly older and larger than the average firm in the respondent sample. However, we found no significant differences between the final sample and the respondent sample in terms of their use of legal mechanisms. Therefore, we do not consider there is evidence of sample attribution bias for the purpose of our analysis.

Measures and Econometric Method

Dependent variables. We employ three measures to indicate various types of firm-level innovative performance. Firstly, we use a variable that captures the ability of the firm to produce radical innovations—*innovations new to the market*. This variable is measured as the fraction of the firm’s sales relating to products new to the market. In the UK innovation survey, firms were asked directly whether their enterprise “introduced any new or significantly improved products which were also new to the enterprise’s market” and “what share of total firm [sales] these products accounted for in [last year of survey]” (DTI 2005). We also incorporated two variables as measures of incremental innovation, including a variable for the fraction of the firm’s sales from product *innovations new to the firm* and a variable for the fraction of the firm’s sales from *significant product improvements*. It should be noted, however, that innovations new to the firm

or significant product improvements are not new to the market and could therefore involve a (high) degree of imitation. Nevertheless, in advanced economies, imitation and innovation are interwoven, so that most innovations involve a degree of simultaneous imitation and innovation (see e.g., Bessen and Maskin 2009). Moreover, imitation is similar to innovation in that it is costly to produce. For instance, in a study of 48 product innovations and their corresponding imitations, Mansfield et al. (1981) found that that imitation is not a costless activity; the cost of conducting the average imitation was approximately 65 percent of the cost of the original innovation. Independent of the level of imitation involved in products new to the firm or significant product improvements, we suggest that these types of innovation are more incremental than innovations new to the market.

Our sales weighted measure of innovation performance is consistent with Schumpeter's (1912/1934) view, since his notion of innovation not only pertains to the capacity to introduce "new combinations" in terms, for instance, of new products, but also to the commercial success of those products. In addition, the measure has been widely applied in the previous literature (Mairesse and Mohnen 2002; He and Wong 2004; Cassiman and Veugelers 2006; Laursen and Salter 2006), and some firms, such as Dupont and 3M, use the percentage of innovative products to benchmark the commercial success of their innovative activities (Kanter et al. 1997). Although single item measurements may be subject to some concern of robustness and validity, Rossiter (2002) suggests—supported by Bergkvist and Rossiter (2007)— that a single-item scale can be recommended when researchers seek to measure an object that in the minds of respondents refers to a concrete object. The percentage of sales from different types of innovation meets this criterion.

Independent variables: For determinants of innovative performance, we introduced a variable reflecting firm-level orientation towards *legal appropriability*. The variable is constructed based on the question in the UK innovation surveys about “the importance to your enterprise” of different methods for protecting innovations. We chose the three legal items that are most directly aimed at protecting technological innovations, “patents”, “registration of design”, and “confidentiality agreements” from the survey. The three items are all measured on a 0-1-2-3 scale, with 0 representing “not used” to 3 representing a “high degree of importance.” To extract information based on these three items, a factor analysis was then undertaken with Varimax rotation (factor loading for patents: 0.91; registration of design: 0.91; confidentiality agreements: 0.84; Eigenvalue: 2.35). The extracted principle factor appears to have a high degree of statistical consistency (Cronbach’s Alpha = 0.86).

In order to capture the relative attention that managers place on legal appropriability, our legal appropriability index is then centered around its industry average; that is, it is calculated as a firm’s deviation in its legal appropriability from the average figure of the 3-digit SIC industry to which the firm belongs (covering 96 industries). This approach allows us to disentangle industry-level appropriability conditions—which affect all firms in the sector—from firm-level strategy, as we measure the extent to which managers deviate from industry norms about the use of legal mechanisms. In doing so, we are able to partially overcome the tendency in the literature to mix industry-level and firm-level measures of appropriability. As such, our measure of legal appropriability is constructed to capture the relative importance that managers place on these mechanisms for protecting their innovations, not just the extent of their use. It appears that many firms use these mechanisms, but do not consider them important. Asking for information simply about the extent of use of different legal mechanisms would not provide a measure of their

importance for the managers who use them. In this respect, the survey is consistent with the Yale and Carnegie Mellon surveys (see for instance, Levin et al. 1987; Cohen and Levinthal 1990; Cohen et al. 2000; Arora and Ceccagnoli 2006). The list of legal appropriability mechanisms in the survey is comprehensive, including the central legal mechanisms mandated by law or by industrial custom available to firms in the UK.³ In addition, since our empirical model includes a squared term based on this variable, we normalized the variable by adding a constant, so that the minimum value of the variable becomes zero.

A key (moderator) variable in our study is *collaboration breadth* (Laursen and Salter 2006) with different types of external partners, based on the question “Did your enterprise have any cooperation arrangements on innovation activities with other enterprises or institutions?” The respondents could chose from a list of six different types of collaboration partners (suppliers, clients/customers, competitors, consultants/commercial labs/private research institutes, universities/other higher education institutes, and government research organizations). Innovation collaboration was defined to the respondents as “...active participation in joint innovation projects (including R&D) with other organizations.” The variable is calculated so that each firm gets a value of zero if they did not collaborate with any type of partner and the value of six if they collaborated with all the partner types (Cronbach’s alpha = 0.89).

Control variables. To avoid obtaining a statistical artifact, we include a number of control variables identified in the previous literature on the determinants of innovative performance. First, *R&D intensity* is measured as firm R&D expenditure divided by firm sales, as a proxy for the level of the firm’s investments in the innovation process. Second, we follow Laursen and Salter (2006) to introduce a *search breadth* variable, in order to take into account the impact of

³ In this respect the UK Innovation Survey is an improvement over the Yale and Carnegie Mellon Surveys that contains only the item “other legal” alongside “patents”.

search strategy on the firm's innovation performance. Third, we control for the firms' *relative weight on informal protection* to ensure our results were not driven by the firm's use of informal mechanisms of protection. Our measure is calculated as the sum of three measures of informal protection (secrecy; complexity and; lead time) divided by 3 minus the sum of three measures of legal protection (patents; registration of design and; confidentiality agreements) divided by 3. Since each of the six items included in this measure can take the values 0-1-2-3, the measure ranges from -3 to + 3. The variable is akin to Arundel's (2001) variable that measures the relative importance of patents relative to secrecy.

Fourth, we control for the *export status* of the firm, including a dummy variable that indicates if the firm has sold product or services outside the UK (He and Wong 2004; Cassiman and Veugelers 2006). Fifth, using data linked in from the ARD, we are able to create *foreign ownership* dummy variables to indicate if the subsidiaries are owned by US parent firms or other foreign firms. Depending on the nature of the inward FDIs in the UK manufacturing sector (e.g. technology-sourcing), the innovation performance of foreign subsidiaries may be expected to differ from that of indigenous firms. Sixth, *firm size* may influence the propensity to innovate. Although empirical research indicates that the advantages of size for innovative performance are ambiguous, size is commonly used as a variable in studies of innovative performance (Cohen 1995). We measured firm size, expressed as a logarithm, by the number of employees. Seventh, analogous to the size effect associated with business scale, we also included a dummy variable *multi-product firm* to indicate if the firm belongs to an enterprise group operating in more than one (5-digit SIC) industry, using matched data from the more comprehensive ARD data source. Eighth, following Cassiman and Veugelers (2006), we introduced measures of the *technological* and *market obstacles* facing the firm. These variables help capture the supply and demand

factors that shape the potential for firm-level innovation (Cassiman and Veugelers 2006: 74).

Technological obstacles are measured by an item on the importance of a “lack of information on technology” and market obstacles are the average of responses to the items “lack of customer responsiveness to new goods and services”, “impact of regulations and standards” and “lack of information on markets” (Cronbach’s alpha = 0.86). As a high perceived level of obstacles can also be a function of high levels of opportunities in the external environment, we normalized the obstacles variables by 3-digit SIC industry averages. Ninth, as the ARD data provide reliable estimate of industry-wide characteristics, drawing on a sample representative of the population of all UK firms, we also controlled for the influence of industry-level environment (e.g. competition and diversity) by introducing an *industry diversification* index as the proportion of 5-digit SIC industries located in the travel-to-work area in which a firm is located. Finally, we included 16 industry controls to account for different levels of innovation intensities across industries (Levin et al. 1987; Cohen et al. 2000) and 11 geographical dummies to account for diversity in the ability to innovate across UK regions (Love and Roper 2001).

Econometric model. The dependent variable in the regression model is censored, since the variable is the percentage of innovative sales and, therefore, by definition, bounded between 0 and 1. Accordingly, following Papke and Wooldridge (1996), we employed the quasi-maximum likelihood estimation (QMLE) (with a logistic mean function) to estimate the fractional response model⁴ of innovative performance. The fractional logit modelling approach accommodates the non-linear relationship between explanatory variables and the dependent variable of innovation performance, which is useful when the marginal effect of an explanatory variable is expected to diminish. Additionally, unlike ordinary least squares, the fractional logit estimator can ensure the

⁴ This procedure can be implemented using a statistical package (e.g., Stata) that estimates a generalized linear model with a binomial distributional family and logit link function and that does not treat the fractional dependent variable as a binary response.

estimate of innovation performance and thus its predicted values are bounded between zero and unity.

Since that management's expectations in relation to performance outcomes with respect to the strategy chosen can lead to statistical artifacts in the form of biased coefficient estimates, we may have an endogeneity problem (Hamilton and Nickerson 2003). These biases can result from omitted variables associated with management's self-selection, which affects both strategy choice and innovation performance (see Wooldridge 2002: 50-51). To meet this challenge, we used our panel to create lagged explanatory variables, with each lagged period covering about four years in duration. Using this approach, largely combats—if not removes—the potential endogeneity issues in the empirical model.

RESULTS

Descriptive statistics and simple correlations are given in Table 1. The table shows that, among other things, on average, 3 percent of firms' sales can be attributed to products new to the market, 4 percent of sales attributed to those new to the firm only and 5 percent attributed to significantly improved products.

Insert Table 1 about here

Table 2 presents three of the legal appropriability methods listed in the survey of manufacturing firms. Among the legal mechanisms, confidentiality agreements are the most important; some 53 percent of firms indicated that they found this method important for appropriation. Only between 37-38 percent of firms indicated patents or registration of designs were used as a method for appropriation. If the importance of appropriability mechanisms across industries (c.f. Table 3) is scrutinized, we find—in accordance with the literature (Levin et al.

1987)—substantial differences, with chemical, electrical machinery and medical instruments etc. firms assigning high levels of importance to legal appropriability mechanisms on average. In general, industries with high levels of investment in R&D are more likely to engage in the use of legal methods.

Insert Table 2 about here

Insert Table 3 about here

Econometric Results

The estimations of the fractional response model are presented in Table 4. When looking at Model I in Table 4, we find initial support for Hypothesis 1 stating that a firm’s orientation towards legal appropriability is curvilinearly—taking an inverted U-shape—related to innovative performance, when innovation performance is measured as innovations new to the market or as significant product improvements but not as innovations new to the firm. Firstly, the parameter for the orientation towards appropriability is significant and positive in explaining innovative performance. Accordingly, firms with an (stronger) orientation towards legal appropriability appear to have higher levels of innovative performance. Secondly, the negative parameter for the squared term is also significant, indicating that when firms become very focused on appropriability, adverse effects set in. However, it should be noted that the top-point of the curve is located outside the range of the independent variable - the orientation towards legal appropriability (and, as we will see below, when considering the moderators, the result is not general).

Insert Table 4 about here

The proposition of Hypothesis 2 that the inverted U-shaped relationship between a firm's orientation towards appropriability and innovative performance is moderated by innovation collaboration, such that the effects of under- and overprotection become less pronounced with innovation collaboration, is tested in Table 5. Overall, the results support this hypothesis. Innovation collaboration has significant moderating effects on legal appropriability. To clarify this complex interaction, we follow Schick and Ponemon (1993) in graphing (in Figure 1) the relationship between the dependent and key independent variables for low and high values of the moderator variable for the estimations found in Table 5. Note that the distribution of this cooperation breadth variable is highly skewed with only some 20 percent of all firms having formal innovation collaboration agreements. . We plot the effects at the 10th percentile (no collaboration partners) and at the 90th percentile (two partner types). Again, we set the dummy variables included in the model to zero while the other continuous variables are set to their sample averages. The graph shows that as expected, the curvature of the relationship is much less pronounced for firms with innovation collaboration, while the effect is very pronounced for firms without innovation collaboration activities. In fact, for collaborative firms, legal appropriability strategy plays a modest role in shaping innovative performance. It can be noted that for firms without formal innovation collaboration, the curve is downward-bending for the firms with the strongest orientation towards legal appropriability. In this case, a (relatively small) group of firms experience an overly strong orientation towards legal appropriability with respect to their levels of sales of innovative products.

Insert Table 5 about here

Insert Figure 1 about here

Hypothesis 3 states that the relationship between a firm's orientation towards appropriability and innovation performance is positively moderated by the degree of novelty of the innovation, so that the inversely U-shaped relationship becomes stronger with greater levels of radicalness. When we move back to Table 4, it is clear that an orientation toward legal mechanisms matters to innovation performance in terms of either innovations new to the market or significant product improvements. However, as expected, the impact of a firm's orientation towards legal appropriability is much more pronounced on sales attributed to radical forms of innovations (e.g. new to the market) compared with those attributed to significantly improved products. Certainly, we find that for new sales for the firm, a firm's orientation towards legal methods matters little. This finding is consistent with Hypothesis 3.

To test our conjecture about the importance of legal mechanisms across industries in Hypothesis 4, we estimated the model separately for industries associated with high and low R&D intensity levels. We did this at both the 16-industry levels (that we use as dummies in the regressions) and at the three-digit industry code level (96 industries). We reported the results using the 13-industry levels in Table 5 (the results for the low industry disaggregation are consistent with what is reported below). In case of high-technology industries, we find little evidence that a firm orientation toward legal mechanisms shapes innovative performance. However, in low-technology industries, there is a strong inverted U-shaped relationship between legal mechanisms and innovative performance. This result is consistent with Hypothesis 4, suggesting that low-technology environments provide greater space for strategic moves regarding the use of legal mechanisms to gain from innovative efforts. It can be noted that for low-tech-firms, the curve is downward-bending: Also in this case, a group of firms experience an over strong orientation towards legal appropriability with respect to their levels of sales of

innovative products.

Among the control variables, the parameters for innovation cooperation breadth, R&D intensity, search breadth and exporting status are consistently positive and significant in explaining the proportion of sales of innovative products. In particular, we found evidence that Laursen and Salter's measure of (2006) search breadth explains innovative performance irrespective of how this is measured; however, such performance effect only seems to exist in industries characterized by low levels of R&D intensity.. This finding suggests that like an orientation towards legal mechanisms, the benefits of search may also be context specific. Subsidiaries of US companies achieved lower performance in radical forms of innovations (perhaps reflecting the predominantly technology-seeking nature of US foreign direct investment in the UK manufacturing) so did the firms belonging to highly diversified industries (especially in high tech industries), whereas firms with a balance in their orientation towards informal appropriability mechanisms had slightly higher innovative performance (although this had little impact in low tech industries). Lastly, there was also evidence for an adverse impact of market obstacles on radical-type innovation performance, which is especially pronounced in the low tech industries.

CONCLUSION AND DISCUSSION

Capturing the profits from innovative activities is difficult and many firms find the rents from their innovations are captured by their competitors, or by owners of specialized complementary assets. Our study adopted a firm-level approach, focusing on how managers' choices about how to appropriate innovations can shape the firm's ability to innovate and to capture the returns from these innovations. In doing so, we have helped to extend our understanding of how firms can proactively create their appropriability conditions by strategic action (Pisano 2006). We found

support for the idea that firms' orientation towards legal appropriability is curvilinearly related to innovative performance. It appears that many firms allocate either too little or too much orientation to legal appropriability, thereby entering a state we termed *protection myopia*. When we compare the number of firms that are either below or above the tipping point we find that by far the majority of firms appear to give too little emphasis to appropriability, while only a relatively small percentage of the firms are situated above the tipping point—and this pertains to low-tech and/or non-collaborating firms only, and not to firms' sales accruing from innovations that are new to the firm only. This suggests that under-orientation is more widespread than over-orientation. This finding supports the conclusions found in the Gowers Review (2006) affirming that a substantial number of managers underemphasize formal IP and that managers are often unaware of how the formal IP system works. In the case of too much focus on legal protection, our findings provide quantitative support for already existing qualitative evidence suggesting that many firms are unable to set their orientation towards legal appropriability effectively. This finding highlights the organizational challenges of putting in place an effective appropriability strategy and how these challenges are often underestimated by managers (Liebeskind 1997).

With respect to the alleviating effect of innovation collaboration, we found support for this hypothesis. Firms with broad innovation collaboration activities with different types of partners are much more likely to have found the right balance in their orientation towards appropriability. For most collaborating firms, formal collaboration has a significant dampening effect on the negative consequences of an under- and overemphasis on legal protection. This may be explained by the idea that firms successfully collaborating for innovation are likely to have developed highly refined mechanisms—including IP—for managing interactions with the external environment. However, an additional explanation for the very pronounced effect may be

self-selection, implying that those firms with the best resources and capabilities are also those that collaborate.

It is also clear that the novelty of an innovation shapes the returns to managers' attention to legal mechanisms. Capturing returns from radical innovations—innovations that are new for the market—demand close attention to legal mechanisms, whereas for more incremental forms of innovation the performance benefits of orientation to legal mechanisms appear to matter much less. Incremental innovations, which are largely imitative, offer less scope for firms to profit from legal mechanisms, which tend to reward novelty and pre-emption.

Our analysis also suggests that the industrial context profoundly shapes the value of applying managerial attention to legal mechanisms. In high-technology sectors, a strong relative orientation to legal mechanisms does not impart an innovative advantage. This result may be largely explained by the strong competitive dynamics of these industries, where legal mechanisms are widely accepted as part of the “industrial recipe” of capturing returns to innovation. In this context, managers who allocate increased levels of attention to legal mechanisms may find that this effort is counteracted by their competitors legal efforts, leading to a negative-sum game where each actor invests managerial time and attention in legal mechanisms only to find that these investments have little or no payoff. In contrast, low-technology sectors, where the pace of innovation and competition is more sedate, managers can gain significantly by allocating attention to legal mechanisms. However, here too, over attention to legal mechanisms may lead firms astray as we found that there were strong negative returns to high levels of relative attention to legal appropriability for many firms in low-technology sectors. This suggests that firms in these sectors should avail themselves of legal mechanisms, but that

such efforts should not distract the firm from the other tasks associated with developing and capturing value from an innovation.

This study has theoretical implications for the attention-based theories of the firm. We theoretically argue and empirically demonstrate that managerial focus on legal mechanisms of appropriability can have important performance implications. This enriches our understanding of how the allocation of attention can enable firms to be forward-looking in confronting important managerial challenges, in this case taking proactive steps to allocate managerial attention to legal mechanisms to capture returns to innovative efforts (Ocasio, 2011). We have also helped to pinpoint the contingencies that moderate the value of attention, especially in the case of the use of legal mechanisms. By demonstrating how these attentional costs and benefits are shaped by levels of collaboration, the degree of innovation and their industrial context, we isolate how organizations can find the correct balance in their attention in the uncertain and complex areas of managerial decision-making.

This study also has important implications for managers. First, the consequences for innovative performance of giving little emphasis to appropriability are severe. Our results indicate that many managers give too little of such emphasis—firms need to invest time and other resources in IP protection. In addition, we show that very strong orientations can also be damaging to innovative performance, especially in low-technology industries. The study of IP protection in management studies often assumes that “more is better” (Rivette and Kline 2000). However, here we found evidence consistent with the idea that an over-emphasis on legal appropriability can be detrimental to innovation performance, suggesting that such a simplistic philosophy will not bring success. Thus, exhortations that firms should acquire stronger IP protection may be harmful to innovative performance if pursued too aggressively. Moreover, we show that building

collaborations can help managers make better decisions about the use of legal mechanisms, enabling them to overcome the dangers of too little or too much legal appropriability.

Limitations and Future Research

The current study is limited by the nature of the data available. Collecting information on appropriability strategies, however, remains a formidable task for researchers. The path-breaking research on appropriability has relied on surveys completed in 1982 (Yale) and 1994 (Carnegie Mellon). The availability of large-scale surveys of appropriability through the use of CIS data can provide an opportunity to extend this work in new directions. Although this paper—based on the use of three waves of the UK innovation survey—provides important evidence about how managerial choices about legal appropriability shapes subsequent innovative performance, this finding requires greater empirical testing to help determine more clearly the direction of causality. Short panels, such as the one used here, can provide evidence of the direction of the relationships between variables, but additional waves of survey data will be necessary to determine more precisely the magnitude of these effects on business performance more generally. Moreover, it would be useful to link these panels to measures of firm's stocks of patents, trademarks and other IP rights.

Finally, our study raises the important issue of a fundamental tension that exists when managers seek to develop innovations—they need to work with external parties while at the same time protecting and exploiting what they know for commercial gain. We still know little about how managers configure the internal and external elements of their firm in a bid to resolve these difficult conflicts. While our knowledge of these issues is still limited, it is our hope that this paper will be seen as an important first step in opening up this research agenda.

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TABLE 1. Descriptive statistics and simple correlations^a

Variable	Mean	s.d.	Min.	Max.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Innovations new to the market	0.03	0.09	0	1															
2. Innovations new to the firm	0.04	0.11	0	1	0.14*														
3. Significant product improvement	0.05	0.14	0	1	0.19*	0.23*													
4. Legal appropriability	1.80	0.94	0	4.32	0.17*	0.12*	0.16*												
5. Innovation cooperation breadth	0.63	1.47	0	6.00	0.21*	0.19*	0.20*	0.25*											
6. Firm size	195.02	511.18	– ^b	– ^b	0.05*	0.02	0.07*	0.17*	0.20*										
7. R&D intensity	1.09	4.52	0	110.20	0.20*	0.09*	0.17*	0.18*	0.22*	0.20*									
8. Search breadth	5.64	3.65	0	10	0.18*	0.19*	0.23*	0.49*	0.34*	0.15*	0.19*								
9. Relative weight on informal protection	0.18	0.72	-3.00	3.00	0.05*	0.06*	0.08*	-0.37*	-0.01	-0.07*	-0.05	0.06*							
10. Multi-product firm	0.41	0.49	0	1	0.03	0.04	0.03	0.22*	0.16*	0.30*	0.08*	0.20*	-0.09*						
11. Market obstacles	0.02	0.77	-1.34	2.42	0.12*	0.09*	0.14*	0.37*	0.16*	0.04	0.12*	0.46*	0.06*	0.06*					
12. Technological obstacles	0.03	0.80	-1.33	2.52	0.10*	0.08*	0.12*	0.34*	0.15*	0.03	0.06*	0.43*	0.06*	0.06*	0.68*				
13. Export	0.61	0.49	0	1	0.12*	0.10*	0.13*	0.27*	0.21*	0.13*	0.15*	0.31*	-0.01	0.21*	0.15*	0.15*			
14. US-ownership	0.05	0.22	0	1	-0.01	0.02	0.00	0.10*	0.07*	0.15*	0.07*	0.10*	-0.03	0.17*	0.04	0.03	0.13*		
15. Other foreign-ownership	0.10	0.29	0	1	0.06*	0.05*	0.03	0.14*	0.11*	0.20*	0.08*	0.12*	-0.08*	0.19*	0.01	0.03	0.18*	-0.07*	
16. Industry diversification	21	39.50	0.08	168.80	0.01	0.02	-0.01	0.05*	0.05*	0.17*	0.06*	0.03	-0.03	0.12*	0.01	0.01	0.05	0.06*	0.09*

^a $n = 6979$. Pearson correlation coefficients (Bonferroni-adjusted); * significant at the 1% level. ^b numbers suppressed in compliance with ONS's rule on disclosive data

TABLE 2. The importance given to different appropriability methods for innovation, average figures for 2002-2008

Appropriability method	Not used	Low	Medium	High
	Percentages			
Patents	63	10	10	17
Registration of design	62	12	12	14
Confidentiality agreements	46	13	19	21
Average	57	12	14	17

TABLE 3. Key innovation and appropriability measures by industry, average figures for 2002-2008

	% of firms that introduced new to the market innovations	% of firms that introduced innovations new to the firm	% of firms that introduced significant product improvements	Average legal appropriability ^a	Average R&D intensity
Food, drink and tobacco	0.21	0.33	0.243	0.71	0.61
Textiles	0.20	0.25	0.204	0.77	0.36
Clothing, leather & footwear	0.11	0.24	0.193	0.70	0.86
Wood products	0.13	0.18	0.157	0.47	0.14
Paper	0.12	0.21	0.177	0.89	0.28
Publishing and printing	0.13	0.24	0.197	0.57	0.47
Chemicals	0.28	0.31	0.301	1.36	3.71
Rubber and plastics	0.25	0.30	0.278	1.10	0.67
Non-metallic minerals	0.19	0.28	0.227	0.89	0.37
Basic metals	0.13	0.22	0.138	0.69	0.35
Fabricated metal products	0.11	0.17	0.148	0.61	0.30
Machinery and equipment					
n.e.s	0.22	0.28	0.295	0.99	1.41
Electrical machinery	0.27	0.36	0.375	1.23	2.75
Medical etc instruments	0.44	0.40	0.486	1.33	3.15
Motor and transport	0.18	0.23	0.224	1.05	1.26
Other	0.19	0.26	0.235	0.80	0.86
Average	0.20	0.27	0.25	0.87	1.09

^a in order to indicate inter-industry variations, legal appropriability computed here are not based on deviation from industry average (as in Table 1)

TABLE 4. Fractional response models for different measures of innovative performance, UK manufacturing firms, 2002-2008

Variables	I	II	III
	Innovations new to the market	Innovations new to the firm	Significant product improvements
Legal appropriability _(t-1)	0.943 *** (0.261)	0.163 (0.169)	0.563 *** (0.167)
Legal appropriability squared _(t-1)	-0.128 ** (0.060)	-0.029 (0.032)	-0.084 ** (0.037)
Innovation cooperation breadth _(t-1)	0.098 *** (0.029)	0.109*** (0.027)	0.084 *** (0.029)
Firm size _(t-1)	-0.038 (0.051)	0.000 (0.049)	0.016 (0.065)
R&D intensity _(t-1)	0.500 *** (0.069)	0.159*** (0.044)	0.320 *** (0.065)
Search breadth _(t-1)	0.045 * (0.026)	0.057** (0.028)	0.071 *** (0.022)
Relative weight on informal protection _(t-1)	0.275 *** (0.105)	0.238*** (0.090)	0.196 *** (0.073)
Multi-product firm _(t-1)	-0.186 (0.135)	-0.037 (0.159)	-0.078 (0.083)
Market obstacles _(t-1)	-0.154 * (0.083)	-0.035 (0.109)	0.130 * (0.071)
Technological obstacles _(t-1)	0.026 (0.076)	0.104 (0.071)	-0.101 (0.066)
Export _(t-1)	0.536 *** (0.198)	0.287** (0.117)	0.074 (0.129)
US-ownership _(t-1)	-0.408 * (0.225)	0.207 (0.207)	-0.021 (0.190)
Other foreign-ownership _(t-1)	0.161 (0.150)	0.423*** (0.081)	0.049 (0.127)
Industry diversification _(t-1)	-0.005 *** (0.002)	-0.001 (0.001)	-0.002 (0.001)
Geography dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Constant	-5.941 *** (0.464)	-4.328*** (0.395)	-4.690 *** (0.385)
No. of obs	3591	3591	3591
Log pseudo-likelihood	-311.9	-470.38	-580.5

Notes: Fractional logit models estimated, based on the pooled quasi-maximum likelihood estimation (QMLE) with a logistic mean function. Clustered and robust standard errors, One-tailed tests: * $p < .10$; ** $p < .05$; *** $p < .01$.

TABLE 5. Fractional response models for innovative performance based on new to the market innovations, UK manufacturing firms, 2002-2008

Variables	Baseline models						Interaction models					
	Full sample		High R&D intensity industries		Low R&D intensity industries		Full sample		High R&D intensity industries		Low R&D intensity industries	
Legal appropriability _(t-1)	0.943***	(0.261)	0.392	(0.425)	1.413 ***	(0.328)	1.145***	(0.278)	0.535	(0.641)	1.599***	(0.330)
Legal appropriability squared _(t-1)	-0.128**	(0.060)	-0.008	(0.097)	-0.247 ***	(0.064)	-0.162**	(0.070)	-0.041	(0.154)	-0.271***	(0.070)
Innovation cooperation breadth _(t-1)	0.098***	(0.029)	0.064	(0.045)	0.111 **	(0.043)	0.379***	(0.147)	0.144	(0.280)	0.499***	(0.144)
Legal appropriability × Innovation cooperation breadth _(t-1)	–	–	–	–	–	–	-0.216*	(0.131)	-0.093	(0.254)	-0.287**	(0.134)
Legal appropriability squared × Innovation cooperation breadth _(t-1)	–	–	–	–	–	–	0.037	(0.027)	0.021	(0.056)	0.045	(0.029)
Firm size _(t-1)	-0.038	(0.051)	0.078	(0.093)	-0.083	(0.072)	-0.033	(0.051)	0.080	(0.093)	-0.078	(0.071)
R&D intensity _(t-1)	0.500***	(0.069)	0.376 **	(0.149)	0.493 ***	(0.096)	0.502***	(0.068)	0.373***	(0.145)	0.494***	(0.096)
Search breadth _(t-1)	0.045*	(0.026)	0.045	(0.065)	0.053 *	(0.027)	0.041	(0.025)	0.045	(0.064)	0.047*	(0.026)
Relative weight on informal protection _(t-1)	0.275***	(0.105)	0.431 **	(0.182)	0.202	(0.123)	0.273***	(0.102)	0.434**	(0.175)	0.195	(0.123)
Multi-product firm _(t-1)	-0.186	(0.135)	-0.216	(0.179)	-0.187	(0.152)	-0.191	(0.132)	-0.215	(0.180)	-0.187	(0.147)
Market obstacles _(t-1)	-0.154*	(0.083)	0.111	(0.232)	-0.315 ***	(0.118)	-0.152*	(0.082)	0.113	(0.223)	-0.301***	(0.117)
Technological obstacles _(t-1)	0.026	(0.076)	0.023	(0.139)	0.046	(0.099)	0.020	(0.077)	0.018	(0.138)	0.029	(0.104)
Export _(t-1)	0.536***	(0.198)	0.802 **	(0.315)	0.417 **	(0.199)	0.529***	(0.197)	0.826**	(0.360)	0.415**	(0.195)
US-ownership _(t-1)	-0.408*	(0.225)	-1.227 ***	(0.318)	0.139	(0.266)	-0.428*	(0.231)	-1.240***	(0.327)	0.120	(0.277)
Other foreign-ownership _(t-1)	0.161	(0.150)	0.195	(0.323)	0.095	(0.256)	0.156	(0.150)	0.187	(0.320)	0.101	(0.258)
Industry diversification _(t-1)	-0.005***	(0.002)	-0.007 *	(0.004)	-0.004	(0.003)	-0.005***	(0.002)	-0.007*	(0.004)	-0.004	(0.003)
Geography dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Time dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Constant	-5.941***	(0.464)	-5.466 ***	(1.074)	-6.128 ***	(0.504)	-6.179***	(0.451)	-5.602***	(1.250)	-6.364***	(0.479)
No. of obs	3591		526		3065		3591		526		3065	
Log pseudo-likelihood	-311.9		-96.0		-207.8		-311.6		-96.0		-207.3	

Notes: ‘Fractional logit’ models estimated, based on the pooled quasi-maximum likelihood estimation (QMLE) with a logistic mean function. Clustered and robust standard errors. One-tailed tests: * $p < .10$; ** $p < .05$; *** $p < .01$.

FIGURE 1. The effect of an orientation towards legal appropriability on innovation performance, moderated by innovation collaboration

