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## **The role of organizational mechanisms in preventing leakage of unpatented knowledge in offshore captive R&D centers**

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### **Abstract**

The offshoring of complex, strategically valuable R&D activities by western based multinational firms to offshore locations with weak IP protection, such as China and India is increasing. In this paper, we aim to understand how firms protect their IP created in such offshore R&D centers. We specifically focus on organizational mechanisms that protect knowledge that is not patented. We explore these mechanisms using an interview and survey data from captive R&D centers of multinational firms in India, where the weak IP regime places weak barriers to knowledge leakage. We identify six organizational mechanisms that increase knowledge secrecy and find that captive center managers implementing these mechanisms are more confident of protecting their IP, even for projects that are at a greater risk of leaking to competitors.

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ABSTRACT

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We specifically focus on organizational mechanisms that protect knowledge that is not patented.

We explore these mechanisms using an interview and survey data from captive R&D centers of multinational firms in India, where the weak IP regime places weak barriers to knowledge leakage. We identify six organizational mechanisms that increase knowledge secrecy and find that captive center managers implementing these mechanisms are more confident of protecting their IP, even for projects that are at a greater risk of leaking to competitors.

## INTRODUCTION

The offshoring of R&D and new product development (NPD) activity by multinational companies (MNCs) to locations with thriving knowledge bases, but inexpensive labor costs, such as the BRICS countries is growing rapidly. Although, such offshore locations are attractive to firms as significant markets and the availability of relatively inexpensive talent pools, they come with one significant cost: their relatively poor protection of intellectual property (IP). In this paper, we investigate the *organizational mechanisms* that MNCs uses to protect their IP from leakage when conducting R&D in offshore locations with weak IP regimes (IPR).

Zhao (2006) using an analysis of patent data suggests that MNCs protect their knowledge in locations with weak IP regimes by performing only those activities in that location that have ‘strong internal linkages’ with complementary activities performed at the headquarters location. Internal linkages have prevented misappropriation of IP since the spillovers at the weak IPR location is of little value without the complementary IP, which is protected in the headquarters country. However, two questions remain unanswered. First, geographic disaggregation of knowledge activities is very difficult to manage (Srikanth and Puranam, 2014; Olson et al, 2002), raising the question of the prevalence of this practice, especially in activities that involve tacit or inchoate knowledge. This especially important for innovations aimed at the local market, which is not protected by the strong IPR at home (cf: Nandkumar and Srikanth, 2015). Second, apart from the geographic disaggregation, what other mechanisms do MNCs use in order to protect their IP created in offshore locations with a weak IPR from leaking to competitors?

Understanding this phenomenon is important for at least three reasons. First, though the practice of R&D offshoring to emerging economies is growing significantly, it is a relatively neglected field of scholarly study. This is perhaps because until recently, the lion’s share of

international R&D activity was confined to MNCs performing R&D in foreign locations that have strong IPRs, such as US companies operating R&D centers in the EU, Japan or vice-versa. Several studies attempt to understand internationalization of R&D, in terms of what activities are offshored, to which destinations, and how knowledge is transferred and integrated globally (Chung and Yeaple, 2008; Feinberg and Gupta, 2004; Nachum and Zaheer, 2005; Kogut and Chang, 1991; Anand and Kogut, 1997; Kummerle, 1999; Mudambi, 2011; Almeida and Phene, 2004; Phene and Almeida, 2008; Kotha and Srikanth, 2013). In contrast to this explosion of research on value creation from globalizing R&D, there is little work on how MNCs protect their offshored IP from leaking to competitors (with the exception of Zhao, 2006).

Second, not only is the volume of R&D activities offshored to weak IPR locations growing rapidly, it is increasingly valuable to MNCs. R&D offshoring to emerging economies has usually been characterized as a response to the need for local customization (Rugman, Verbeke and Nguyen, 2011; Kummerle, 1999), and therefore of low strategic value to the MNC. However, this portrayal is no longer accurate. Lewin et al. (2009) from their survey of offshored activities find that accessing high quality talent in science and engineering, particularly in India and China, is one of the most important reasons for MNCs to offshore R&D work. There is a strategic shift in offshore operations of the MNE towards undertaking increasingly novel and complex work (see Kumar and Puranam, 2012 with respect to India), such as developing new product and process designs and services for global (western) markets (Zhao, 2006; Mudambi and Venzin, 2010). Hegde and Hicks (2008) argue that emerging economy R&D captive centers are now well enmeshed in the R&D value chains of large MNEs, and several scholars have suggested that captive center patents have a high internal impact (Alnuaimi, George and Puranam, 2012a; Alnuaimi, Singh and George, 2012b; Singh, 2008). With captive centers now

performing work of high strategic value to the MNC, it is that much more important for MNCs to protect its knowledge resources resident in these centers from leaking to competitors.

Finally, it is currently unclear how MNCs protect their IP generated or used in these offshore R&D centers from leaking to competitors. One obvious way to protect these knowledge resources is through increased patenting of knowledge produced in these centers, and indeed, concurrently there is a large increase in patenting activity, both in the US PTO and in the host countries, by these offshore captive centers in recent years.

However, often more extensive patenting is not the answer to stem knowledge leakage. Not all types of knowledge resources are patentable. Knowledge resources that are sticky or uncodifiable can leak out to rivals through the mobility of employees, especially to local competitors since knowledge spillovers tend to be local (Almeida, 1996; Almeida and Kogut, 1999; Marx et al, 2009). Whereas in the US, non-compete agreements may be effective in preventing the mobility of employees between competitors (based on the jurisdiction), such contracts are minimally enforced in many offshoring destinations. Coupled with the fact that turnover among the labor pool is quite significant in many prominent offshoring destinations, such as India, (Manning, Massini and Lewin, 2008; Wood, 2012) with firms often “poaching” away talent from their rivals, protecting unpatented knowledge is a significant challenge. In addition, given the relatively weak patent laws and a lack of enforcement in India or China, even with a patent, the MNC may not be confident of protecting its knowledge resources resident in the captive centers. In several surveys, MNC executives have expressed discontent with the extent of IP protection available in the main offshore destinations such as India and China (for example, see EIU, 2010; Thursby and Thursby, 2006 and Kumar and Puranam, 2012). Therefore, MNCs performing R&D in emerging economy offshore destinations with weak IPRs, instead of

relying solely on the legal IPR regime, may also need to put in place organizational mechanisms and processes, such as tight internal linkages (Zhao, 2006) that can impede the leakage of proprietary knowledge to competitors. Currently, it is unclear what such mechanisms may be.

This specific challenge faced by MNCs in protecting their offshored R&D also points to a relatively unexplored topic in the broader innovation literature. The bulk of what we know about how firms appropriate value from R&D is based on patent data (James, Lieblin and Su, 2013). However, with a few exceptions, patenting provides only imperfect or no ownership rights on innovations in many industries (Cohen et al, 2000; Lanjouw and Schankerman, 2001), and often imitators are able to work around patents (Mansfield, Schwartz and Wagner, 1981). Other mechanisms that firms rely on for appropriating value include secrecy, speed to market and access to complementary assets (James et al, 2013; Lemley and Sharpiro, 2005). Secrecy refers to the firm's efforts to withhold details of its innovation from public dissemination (Winter, 2000). Lead time advantage arises from early timing of developing and introducing an innovation, typically arising from superior absorptive capacity (Lieberman and Montgomery, 1988). Finally, protection from complementary assets arises from preferential access to assets needed to commercialize an innovation such as for manufacturing, distribution or service (Teece, 1986). The comprehensive review by James et al (2013) shows that so far there has been limited empirical research on *how* firms protect their (unpatented) knowledge from leakage. Their review also shows that the bulk of empirical research relies on patent data even when the appropriation mechanism under investigation is not property rights granted by patent protection. For example, authors may show a patterns in backward or forward citations of patents to infer an advantage from absorptive capacity or differences in firm strategies (cf: Wang and Chen, 2010).

Especially, there are limited empirical studies on what organizational mechanisms facilitate keeping their knowledge secret. Liebeskind (1996; 1997) theoretically argued that firms can use organizational mechanisms such as incentives, job design and monitoring to reduce leakage of a firm's proprietary knowledge to its competitors. Given the increased use of open sources of knowledge by firms (Chesbrough, 2003; Parmigiani and Mitchell; 2009; Helfat and Quinn, 2006; Arora et al, 2014), and the geographically unbounded nature of knowledge work, especially in our context of R&D offshoring, it is unclear which of these mechanisms are more or less relevant in protecting knowledge from leaking to competitors. In our context, emerging market competitors, being new to technology work, may not be deterred by mechanisms such as path dependence (cf: Helfat, 1994). Therefore, we believe it is time to take a fresh look at the organizational mechanisms that firms use to protect their unpatented knowledge. In this paper, we examine what organizational mechanisms MNCs use to protect their offshored knowledge and whether they promote secrecy or lead time advantage.

We adopt a multi-method approach to study how MNCs protect their valuable unpatented knowledge from leaking in offshore locations with weak IP regimes. First, we conducted field interviews with over twenty R&D managers in MNCs and IP lawyers to obtain a rich description of some of the organizational mechanisms that firms use to protect their unpatented knowledge. From our interviews, we identified six organizational mechanisms that MNCs use to increase secrecy of their knowledge and thus protect it from expropriation. The findings from these interviews became the input to our survey study. We analyzed survey data from 142 offshored R&D and NPD projects carried out by western headquartered MNCs in their captive R&D center in India. First, we use t-tests to show that individual organizational mechanisms are associated with greater confidence on the part of captive managers in protecting their IP. Next, we use a

canonical correlation analysis to show that using these organizational mechanisms as a set is associated with managers' confidence in protecting IP. This analysis is very similar to the one used by Szulanski (1996) in his pioneering work on uncovering organizational impediments to the transfer of best practices within firms. We also show that managers' confidence in protecting their IP is positively related to the captive center to engage in projects that have an inherently higher risk of knowledge leakage, which suggests that this confidence stems from implementing organizational mechanisms rather than from project selection.

We contribute to the literature by identifying six organizational mechanisms that firms can use in protecting their unpatented knowledge from leaking to competitors. Given the paucity of studies on this topic, our analysis is indicative, aimed at informing future in-depth studies regarding the choice of specific knowledge protection mechanisms their inter-relationships. We note that each of these six mechanisms protects knowledge by making it more difficult to access and recombine, even within the firm. This suggests that organizational mechanisms that foster value appropriation may militate against value creation, a trade-off that we believe is not sufficiently examined in current research. We hope that our preliminary analysis inspires future studies on the broader topic of how firms protect their knowledge assets, and how firms trade-off value creation activities with value appropriation concerns.

### **Study 1: Qualitative study using field interviews**

In order to understand how firms protect their knowledge from leakage, we first conducted a qualitative study by interviewing R&D managers in several organizations. We chose a field study since there is little work on how organizations protect their unpatented knowledge from leakage in general, and almost none on how this is managed by MNCs in the context of offshoring R&D. Most prior studies on appropriating knowledge argue that such knowledge is

not valuable to competitors because of firm strategy or requiring complementary assets (Wang and Chen, 2008; Helfat, 1994), and typically validate their results using patent citation data. These assumptions are not fully consistent with the extreme sensitivity of managers to the loss of IP, especially to the loss of trade secrets (EIU, 2010; Kumar and Puranam, 2012; Thursby and Thursby, 2006). As discussed earlier, Zhao (2006) and Alcacer and Zhao (2012) propose thick ‘internal’ linkages as the mechanism used to prevent IP leakage. They test these arguments by counting the ratio of self-forward citations to forward citations for patents developed in the offshore location and filed in the USPTO. A few scholars have suggested that this measure picks up the relative value of these innovations to the firm compared to competitors rather than internal linkages (Alnuaimi et al, 2012a; 2012b; also see Hall, Jaffe and Trajtenberg, 2001; 2005). In sum, there are few studies on how unpatented knowledge is protected, especially in weak IPR locations.

We conducted over twenty interviews with managers of captive centers in India that perform R&D or NPD work, two interviews with R&D managers in the headquarters location, and four interviews with IP lawyers. Our respondents in the captive centers typically had the roles of senior project managers, R&D heads or captive center heads in these firms. While our cases were selected on a convenience sample basis, they were from large well-established captives in the energy, pharmaceuticals, semiconductor, IT hardware and software industries; sectors in which R&D or NPD offshoring work is widely undertaken. These interviews were free flowing, where we asked the managers to describe how they protected their knowledge from leaking to competitors as a result of employee mobility between firms. Interviews ranged between 45 and 100 minutes. Most interviews were done in pairs and the interviewers took extensive notes which were compiled the same day. Managers were asked to provide specific

examples of organizational mechanisms used in their projects rather than just a general overview of what they believe.

These interviews were analyzed using a repeated readings technique to understand the mechanisms used and how they help in preventing knowledge leakage. We compared the mechanisms we uncovered with prior studies on R&D offshoring and on knowledge leakage to understand how they related to prior findings. Combining our findings with those from prior work, we describe below the set of six organizational mechanisms that impede imitation of the MNC's knowledge. These findings became the input to our survey study that is described later.

In general, MNC managers described their two principal concerns regarding the leakage of their proprietary knowledge from the captive center. First, domestic competitors may enter domestic (host) markets to reduce the rents of the MNC. India and China are large markets in their own right, but domestic competitors may use expropriated IP to enter related markets such as Thailand or Vietnam. Second, knowledge leakage from the MNC may increase the absorptive capacity of the emerging economy competitors, enabling them to compete with the MNC globally in the future. For example, firms such as Huawei and Zhongshen are now serious competitors to MNCs in global markets. Our main premise, borne out in our interviews, is that personnel mobility is a key factor in enabling knowledge leakage to competitors, especially of tacit knowledge and trade secrets. Therefore, we focus mainly on uncovering mechanisms that MNCs use to prevent their former employees from misappropriating their IP on behalf of competitors.

### **Findings from Study 1: Organizational Mechanisms that impede knowledge leakage**

From our interviews we identified six organizational mechanisms that MNCs use to prevent the leakage of their proprietary knowledge to competitors. These are mechanisms firms

put in place over and above their HR policies for retaining employees, such as generous compensation plans or interesting work (cf: Olander and Hurmelinna-Laukkanen, 2015). Organizational mechanisms we studied operate on the knowledge assets themselves, rendering these assets (partially) immobile, and complement policies that focus on employee retention. We did not encounter all six of these mechanisms in any single firm and by nature a qualitative study cannot be precise about the prevalence of any of these mechanisms in general or in specific sectors. In this section, we describe in detail the six organizational mechanisms we encountered in our study and how they protect (unpatented) knowledge from leaking to competitors.

***1. Involvement of headquarters personnel in R&D projects executed by the captive center:*** The first mechanism we discuss is the division of work such that knowledge regarding the innovation is distributed across two or more locations, typically, between the captive center and the headquarters location. We discuss this mechanism first because it is discussed in prior research on our specific context as ‘fine-slicing’ (Zhao, 2006; Quan and Chesbrough, 2010). This mechanism entails the disaggregation of R&D and NPD activities between the location in which the MNE is headquartered (HQ location henceforth, which is assumed to have a strong IPR) and the offshore location (with a weak IPR). This mechanism protects the focal MNE’s knowledge resources from leaking out in two ways. First, if the know-how associated with the focal innovation in the different locations are complementary, the knowledge generated at the offshore location may be of little value by itself without the knowledge generated at other locations. To the extent that complementary knowledge is protected, say at the HQ location, leakage of knowledge at the offshore location is of little concern. Second, distributing knowledge across locations protects knowledge by taking advantage of the nature of knowledge spillovers. Since tacit knowledge spillovers are predominantly local (Almeida, 1996; Almeida and Kogut, 1999),

the focal innovation is less likely to be copied, since it is more difficult for competitors to successfully recombine knowledge from different locations. This is because recombining knowledge across geographic locations is easier within firms (Almeida, Song and Grant, 2001; Srikanth and Puranam, 2014). Therefore, by fine-slicing, the focal firm effectively limits its spillover threat to other MNEs that are also present in the same locations as itself. In essence, this strategy protects knowledge by promoting secrecy as well as by increasing lead times since it may a long time for the competitor to access and recombine the complementary knowledge that is available in the headquarters location. These arguments suggest that firms that proactively configure their R&D projects to achieve fine slicing are less likely to be subject to knowledge leakage even in weak IPR locations.

Our interviews bear out this intuition. For example, a manager in one of the largest R&D captives for a Fortune 50 firm located in India told us that the firm has multiple R&D centers in different geographies and each of these centers was responsible for executing work in their area of competence. Some of these centers had competence in multiple technology domains whereas others were more specialized. Individual R&D centers tended to perform more basic research, or as the manager put it ‘8-12 years to product’ relatively independently. However, more applied work that was ‘3-5 years to product’ was systematically distributed across multiple R&D centers in different countries. One reason for this approach was to staff the project with the best scientific talent available. Another important reason, according to this manager, was to distribute knowledge regarding specific products widely within the firm and not concentrate them in one location. This suggests that fine-slicing at this firm was a deliberate choice to minimize knowledge leakage regarding a product from one location. On further probing, the manager responded that all major projects in this captive center, regardless of whether they were aimed at

developed country markets or to the Indian market were performed in this manner, though it is unclear whether projects conducted in, say Germany for those markets were similarly distributed.

*P1: Managers of projects in offshore captive centers that involve significant levels of headquarters personnel are less likely to be concerned about leakage of proprietary knowledge.*

**2. Interdependence across locations:** In practice, fine slicing may be implemented in two ways. (a) R&D tasks across the different locations can be modularized with minimal interaction between the R&D teams at different locations or (b) make tasks interdependent across locations so that there are frequent interactions between R&D personnel across locations. Zhao (2006) suggests that fine slicing policies are likely to be implemented in a modular manner. Liebeskind (1996) also argues that organizing work in a modular way likely minimizes knowledge leakage from the firm, since each individual only knows about one component. On the other hand, prior research on offshoring of knowledge work finds that modularization of activities across locations may be impractical (Kotha and Srikanth, 2013; Mani et al, 2014; Leonardi and Bailey, 2008).

We find that firms organize their R&D projects by building interdependence between the HQ and the captive center. High levels of interdependence increases social complexity of knowledge, where knowledge is held in the relationships between individuals rather than by the individuals (Winter, 2000), thereby improving secrecy. Another reason to promote high levels of interdependence is that modular knowledge can be more easily copied (Ethiraj, Levinthal and Roy, 2008). Even when complementary modules are not available to a firm, spillovers of modular knowledge can help increase the absorptive capacity of domestic imitators, which may lead to further expropriation of knowledge (Shih, 2010).

For example, a senior manager in a large global pharmaceutical company told us that as the firm's captive center gained in maturity, it has increasingly performed more and more

valuable R&D that is relevant to the core offerings of the company. For instance, the captive center matured from performing clinical trials in India, followed by taking over responsibility for end-to-end clinical trials management for certain drugs across several geographies. This captive has now matured into performing various critical R&D activities in drug design and formulation. The manager said that as the R&D capability has moved closer to the firm's core, the work in the captive center has become more interdependent with the global discovery efforts. Whereas, earlier the firm spent a lot of time designing protocols and modularizing the development effort, with the core R&D functions, interaction with the other R&D centers has risen significantly. The manager suggested that the firm has deliberately created an environment of active collaboration between inventors at its headquarters research labs and its captive center. Therefore:

*P2: Managers of projects in offshore captive centers that involve significant levels of interdependence between the activities conducted at the captive location and other (headquarter) locations are less likely to be concerned about leakage of proprietary knowledge.*

**3. Employee knowledge related to firm-specific assets:** Another aspect of project configuration that we found plays a role in protecting proprietary knowledge is the tight relation between employee knowledge and assets owned by the firm. In this case an employee's most valuable knowledge is intimately connected to the specific physical and knowledge assets available within the firm, which may not be available with other firms. Such tight coupling between employee knowledge and a firm's physical assets in R&D helps protect such knowledge from leakage, since a competitor needs to make investments in similar assets in order to effectively use the expropriated knowledge.

This role of physical and knowledge assets in protecting knowledge from leakage is different from the notion of complementary assets (Teece, 1986) or bundling (Arora, 1996) in an important way. Complementary assets allow for effective commercialization of knowledge. It may however be the case that a firm may choose to pursue only those innovations for which it possesses superior complementary assets. Apart from assets required for commercialization, other assets such as those necessary for manufacturing may also influence such path dependence in R&D (Helfat, 1994), which may prevent an imitator firm from taking full advantage of the knowledge possessed by the focal firm's ex-employee (cf: Song, Almeida and Wu, 2004).

In contrast, we highlight the case where an employee's knowledge is tied to the physical or knowledge assets owned by the firm, which significantly influence the process of generating innovations. Once these assets are not available, the productivity of the employee's knowledge reduces significantly. Our finding also builds on the notion of path dependence. Even though path dependence may prevent a competitor from utilizing all knowledge available with a mobile employee, they could still appropriate value from specific key ideas (cf: Mansfield et al, 1981; Mansfield, 1985). Our data suggests that when knowledge is intimately tied to the focal firm's assets, such knowledge cannot be replicated in a competitor's lab, thereby preventing imitation. In other words, knowledge tied to proprietary assets help value appropriation essentially by building secrecy rather than the traditional role of complementary assets.

For example, in our field work we studied a captive center for a pharmaceutical company that specializes in biologics and large molecule research, a technology in which patent protection is weaker than in typical small molecule drugs. This center has made investments in physical assets such as labs and equipment for testing. It also has unique procedures for validating its computational models for designing proteins. It spends significant effort in training

its employees to get them up to speed in using these protocols. An employee who leaves this firm for a competitor is not able to utilize much of their knowledge in drug design since the competitor will not have the same equipment and protocols; the practically valuable knowledge is tied to the lab itself. Similarly, we witnessed a captive center in the [sector] whose modeling capabilities were tightly linked to the firm's unique test facilities that operated in another country. Therefore, employee mobility is not a significant threat to IP protection for this company. This suggests the following proposition:

*P3: Managers of projects in offshore captive centers that involve a high level of specific assets in its captive center's activities are less likely to be concerned about knowledge leakage.*

**4 and 5. Headquarters (HQ) control and information transfer:** As discussed before, when projects are highly interdependent between the HQ location and the captive center, these projects often have high levels of involvement by engineers and managers from the HQ location. Such high levels of involvement are often accompanied by a significant level of information transfer through formalized routines of communication and documentation between the two sites. However, often there are high levels of information transfer between the HQ and the captive center even about projects in which HQ personnel are not deeply involved. Many R&D captive centers also witness a greater degree of control exerted by the HQ on their operations. Whereas in our fieldwork we were unable to collect specific comparative data on the degree of control exercised by headquarters on offshore captive centers located in host locations with weak IP regimes relative to host locations with strong IP regimes, anecdotal evidence suggests that that may indeed be the case.

A greater level of information transfer between the captive and the HQ location influences the protection of proprietary knowledge in two ways. First, it provides HQ with

adequate and timely information to spot and understand emerging nascent ideas at the captive center, some of which could then be nurtured by providing relevant complimentary knowledge from other locations. This in turn, will create a more valuable idea that is also now more difficult to imitate. Second, with the HQ better informed about the projects at the captive center it can respond more swiftly to limit leakage risk of new ideas. It could do that by either aggressively protecting promising new ideas by documenting them, clarifying the scope of knowledge that is proprietary and confidential to the firm, and perhaps even seeking patent protection before the knowledge leaks with the innovator who may decide to depart from the organization. These two mechanisms can therefore appropriate value from knowledge by increasing secrecy.

In our field work we encountered several captive centers adopting such practices. Some of these captives, especially those that were more concerned about the imitation risk had invested in facilitating a high level of information transfer between locations. We also encountered varying degrees of control that the headquarters exerted over the project selection and the design and implementation details of the projects, whereas a few took a more hands-off approach. Once again, these appeared to be motivated by the perceived imitation risk. For example, one software developer that is often humorously depicted as having more managers than developers, has a number of employees whose primary task is to coordinate work between the captive center and the parent lab in the USA. This captive center was involved in producing important components for the overall product the firm was building. In this case, the HQ lab was heavily involved in relatively detailed decisions regarding the design and building of the components at the captive center. Ideas generated in the captive was documented and discussed with HQ. Typically, the HQ lab decided which innovations were pursued, sometimes with modifications, in the captive center, whereas other knowledge was further developed in the firms' other labs. In contrast,

another software development firm's captive center primarily performs customization and product enhancement type work for innovations generated elsewhere. This firm relies on its very strong complementary assets for commercialization, and in this case, the captive center neither has a very strong connection with the HQ nor were its activities and projects heavily influenced by the HQ. The manager suggested that when employees come up with new ideas, they are likely to stay because this firm is likely to better commercialize this idea than any competitor, and therefore, there was little need for significant controls from HQ. Thus,

*P4: Managers of projects in offshore captive centers that entail a high level of control from the HQ are less likely to be concerned about knowledge leakage to competitors.*

*P5: Managers of projects in offshore captive centers that entail a high level of information transfer with HQ are less likely to be concerned about knowledge leakage to competitors.*

**6. Internal controls on knowledge access:** Captive centers also rely on several internal controls in order to protect proprietary knowledge. The primary aim of these controls is to withhold unlimited access to confidential information by dispersing the critical knowledge within the captive – knowledge leakage is prevented because knowledge regarding critical aspects in the project are now held by multiple individuals and no single person is able to access the information required to replicate the captive center's innovation. This is akin to the principle of disaggregation in job design as suggested by Liebeskind (1996). Internal controls help maintain knowledge as secrets thereby increasing their appropriability.

In our fieldwork, we observed several types of internal controls companies used: (a) storing information in multiple databases each with their own access protocols; (b) storing information in servers located outside the offshore location with controls regarding who can access such information; (c) read, write, and download/print access restricted according to

employee role in the project; and (d) physically segregating teams working on different projects with restrictions on access to the different work areas. In some firms, the physical layout is designed with the aim of minimizing interactions between different project teams. Apart from these practices, many captive centers take steps to educate employees regarding the importance of IP management and put in place active monitoring systems. For example, confidential documents are clearly marked as such so employees are aware that they are working with proprietary information. Thus, we propose that:

*P6: Managers of projects in offshore captive centers that exhibit a high level of internal controls are less likely to be concerned about knowledge leakage.*

### **SURVEY OF R&D PROJECTS IN OFFSHORE CAPTIVE CENTERS**

Using a qualitative approach we identified the above mechanisms that managers use to ward-off IP leakage threats. A robust empirical testing of this idea, however, faces several challenges. Though we interviewed several managers we are unsure about how generalizable our findings are. We do not know how widely these mechanisms are adopted, and if there are sector or technology specific patterns. For instance, analyzing our interviews we found that no firm employed the complete set of mechanisms described above. We also do not know the relative importance of each of these mechanisms, and whether they complement or substitute each other. Therefore, we adopt an approach of providing empirics that demonstrates the phenomenon and provides some insight to help develop future research. For this purpose we surveyed R&D managers of MNE's offshore captives located in India.

#### **Survey Data Description**

We collected survey data from 142 R&D organizations established by MNEs in India. The survey was part of a larger project that was aimed at understanding management and

organization of offshore R&D captive centers. The sampling frame for the survey was obtained from a comprehensive census of captive R&D centers of MNCs conducted by Zinnov Consulting in 2009. Zinnov's census comprised an installed base of nearly 600 captive R&D centers in India, including 452 centers established by publicly listed MNCs. We performed a preliminary check to ensure that these R&D centers actually performed R&D or NPD work rather than routine IT or back-office operations, and removed such firms from the sampling frame.

The unit of analysis is an R&D or New Product Development (NPD) project, and most survey questions related to the characteristics and management of that specific project. Survey respondents were project managers, who were responsible for the execution and delivery of large, strategic R&D projects, and responded to the survey questions regarding what they mechanisms were actually adopted in relation to these projects. It is important to note that managers were not expressing their opinions regarding what is desirable; rather they were responses recorded what was actually implemented. The managers provided a short written summary of the aims of the project to validate whether the response was indeed in the context of an R&D or a NPD project. The survey instrument was designed based on a review of the literature and our interviews. The instrument was pre-tested with managers to examine content and face validity and remove ambiguities in interpretation. The insights from this pilot were used to revise the questions. We requested and received only one response per MNC for only one of its captive centers. Three hundred pre-committed surveys were mailed, with follow-up letters five weeks later. We received a total of 163 valid responses. 21 responses did not pertain to a R&D or NPD project, and were therefore removed from the following analyses.

All respondents were assured that their responses would remain confidential and results would be reported only in aggregate, thereby, addressing privacy concerns and minimizing

potential bias in self-reported data. There were no systematic differences in industry, firm or task attributes between the respondent sample and the larger population, suggesting that concerns of non-response bias were minimal (Armstrong and Overton 1970; Poppo and Zenger 2002). We also performed Harman's one factor test to check for common method bias (Podsakoff *et. al.*, 2003). In the analysis, a single factor did not explain a majority of the variance across all our variables, suggesting that this may not be a significant concern in our data. Since obtaining data on actual offshoring implementations is rather difficult, prior work in this domain has also used a single survey instrument to measure both independent and dependent variables, similar to our work (Mani et al, 2014; Lewin et al, 2009; Larsen, Manning and Pedersen, 2012).

## Measures

*Confidence in knowledge protection:* In our context, we do not expect managers to strongly rely on legal mechanisms such as patents to protect their knowledge. Thus, our first dependent variable was manager's beliefs in effectively protecting their unpatented knowledge or trade secrets and it was measured using a single-item measure: "Trade Secrets are an effective way of protecting our IP" on a 1 to 7 (where ' 1= strongly disagree and 7 = strongly agree) scale. We dichotomized this variable for use in the t-tests, which is the first part of our analyses. We create an indicator variable, with confidence in effectiveness of trade secrets =1 if managers strongly agreed with the above statement by scoring 6 or 7 in the above scale, and zero otherwise. In our sample, 108 managers (76% of the data) had strong confidence in trade secret protection, whereas 34 managers (24% of the data) did not. We should note that in our empirical context, relying on legal mechanisms such as NDAs in order to protect trade secrets is unrealistic; therefore managers who believe trade secrets are effective in protecting their knowledge necessarily need to have put in place organizational mechanisms that deter knowledge leakage.

Note that managers are answering this question in the context of the specific project that they are currently working on, and not their general belief about how knowledge could/should be protected.

We tested the robustness of this variable with another single item measure that is worded to closely relate to the specific threat of leakage we identified in our context, i.e., the mobility of employees between firms. Managers rated their agreement, again on a 1-7 scale, with the following statement: “we have put in place effective safeguards to protect our knowledge if an employee leaves the organization”. We dichotomized this variable as described above, with 104 managers showing strong confidence and 38 managers (27% of the data) that did not.

*Project riskiness with respect to knowledge leakage:* The characteristics of the project and the knowledge involved may influence the extent of risk of knowledge leaking out to competitors. Thus, we created a second dependent variable to reflect this aspect. Based on our field work, we measured it using the following four constructs. (1) Generality of the project, which measures whether the project knowledge is generally useful to competitors. For example, R&D projects that rely on a firm’s complementary assets are not generally useful. Generally useful projects have a higher risk of leakage than knowledge that is only useful to the focal firm. (2) Extent of use of firm’s prior knowledge, which measures the extent to which the project uses the pre-existing knowledge from the firm. When a project uses a firm’s pre-existing knowledge in the captive, the risk of leakage is higher since it places in jeopardy its pre-existing knowledge that so far may not have been available to its competitors. (3) Radicalness of the project, which measures the extent to which the current project is expected to generate a major technical advance. Radical innovations maybe more valuable and therefore may attract more imitators. (4) The codifiability of the project, which measures the extent to which the project’s knowledge is

codified. The more codified the knowledge base, the more easily it leaks. The specific measures for each of these constructs are provided in Table 1. The higher the levels of these four constructs, the more the project is at risk of knowledge leakage, and therefore captive center managers should be less confident in protecting their IP. In our analyses, we tested each of these components of project riskiness independently, as well as a composite variable of project riskiness that includes all these components.

*Organizational Mechanisms to protect IP:* The main independent variable for this study is the extent of adoption of organizational mechanisms and processes that protect a firm's valuable knowledge from leaking to competitors by means of employee mobility. The qualitative study identified a set of six such organizational practices: (a) involvement of personnel from HQ because of IP leakage concerns (b) high levels of task interdependence across locations, (c) projects using firm-specific assets, (d) high levels of information sharing across locations, (e) control over the project by HQ, and (f) implementing internal controls to restrict knowledge access. We measured each of these constructs using multi-item scales. The items that we used to measure the extent of adoption of these mechanisms in the project along with their respective scale reliability coefficients are shown in Table 1. All the scales displayed a Cronbach's alpha above 0.70, which is generally used as a cut-off for scale reliability (Nunally and Bernstein, 1994; Srikanth and Puranam, 2011). In our analyses we tested the importance of each of these mechanisms, as well as their collective influence on manager's confidence in protecting their IP from leakage.

INSERT TABLE 1 HERE

## Analysis

The guiding principle for our empirical analysis is that implementing certain organizational mechanisms or project management practices makes leakage of knowledge more difficult. Therefore, we first examine whether the adoption of these mechanisms is correlated with the manager's confidence in protecting their IP. For this purpose, we compare the mean levels of deployment of organizational mechanisms across the sub-samples of managers with high confidence versus low confidence and test whether these are statistically different from each other. We also show that the use of these organizational mechanisms positively correlates with captive centers performing the type of projects that are at greater risk of knowledge leakage.

Next we present a canonical correlation analysis between managers' confidence in protecting their knowledge and adoption of the set of organizational mechanisms identified above. Canonical correlation analysis is appropriate when attempting to show a relationship between two sets of variables, each of which is composed of multiple correlated items. This analysis is considered most appropriate when the constructs of interest cannot be measured or expressed by a single variable in isolation, which may at best only be indicative of only a part of the overall relationship (Carmeli and Tishler, 2004; Hair et al, 2009). For example, our argument is that a set of organizational mechanisms help protect a firm's unpatented knowledge – though each project may adopt only a sub-set of these mechanisms. Under these conditions, regression analysis may not show relationships between any of these single items in the LHS and RHS. Canonical correlation analysis has been employed in prior strategy research when tackling research questions posing the same empirical characteristics as our own. For example, Szulanski (1996) shows a canonical correlation between different measures of difficulty of transferring knowledge within the firm and the presence of multiple factors that give rise to internal

stickiness. Carmeli and Tishler (2004) investigated the relationship between intangible organizational elements and organizational performance using a similar analysis technique.

Finally, as a robustness check, we use a linear regression analysis to show the association between managers' confidence in protecting their proprietary knowledge and the implementation of multiple organizational mechanisms after controlling for a variety of project and captive characteristics such as captive age, captive size, R&D intensity and industry. We also use a regression analysis to show that captive centers that are more confident of protecting their IP are more likely to perform projects with a higher risk of knowledge leakage. For these regressions, we created the dependent variables 'confidence in knowledge protection', and 'project riskiness with respect to knowledge leakage' and independent variable 'implementation of organizational mechanisms' by using the loadings obtained in the canonical correlations between the constructs and their canonical covariates.

## RESULTS

Recall that our main argument is that firms that employ the organizational mechanisms we identified in the field study are more likely to protect their proprietary knowledge from leaking to competitors. Therefore, projects with high levels of implementation of these mechanisms should be positively correlated with managers' confidence in protecting their IP. The correlation between variables is shown in Table 2.

*Comparison on means analysis:* Table 3a shows how the level of implementation of the organizational mechanisms of interest differs between the "high" and "low" confidence groups. t-tests of the difference suggests that our propositions are empirically plausible. For example, Table 3a suggests that the involvement of personnel from other locations was about 0.12 standard deviations higher when managers were also more confident of protecting their proprietary

knowledge whereas the same organizational mechanism was about 1.02 lower when they were not confident. Our results are qualitatively identical regardless of which measure we use to identify the more confident vs. less confident groups.

It is however plausible that managers who are more confident about protecting their knowledge perform different kinds of projects than those who are less confident. Thus our results might just pick up differences in the nature of projects which may be correlated with the different organizational mechanisms we argue for. For example, it is plausible that managers of projects that involve innovations that are firm-specific and not valuable to competitors are more confident about protecting their IP on average, whereas managers of projects that involve high levels of codified knowledge are likely to be less confident of protecting their IP on average. In order to rule out this possibility, we test whether projects managed by confident managers are systematically different from those managed by those who are less confident.

To this end, from our field work, we identified four characteristics that make a project more risky from a knowledge leakage perspective as described in the previous section. We would expect that managers of projects that are at a greater risk of knowledge leakage are less confident about protecting their IP. In contrast, if the differences in Table 3a were driven by the association between the organizational mechanisms and its ability to ward off leakage threats, then a more confident manager, who has implemented these organizational mechanisms, might just undertake riskier projects. Similar to the above analyses, we perform simple t-tests of difference in means of these project characteristics across the confident and less confident sub-samples.

Table 3b shows that more confident managers perform projects that have an inherently *higher* risk of knowledge leakage. More confident managers are likely to manage projects that are likely to produce innovations that are generally useful to other firms rather than being firm-

specific more radical innovations, use more prior knowledge of the MNE, and use more codified knowledge. These results once again suggest that the deployment of organizational mechanisms discussed above leads to greater confidence in protecting knowledge, which in turn enables these managers to offshore projects that are at a greater risk of IP leakage.

PLEASE INSERT TABLE 2, 3a and 3b HERE

*Canonical correlation analysis:* We performed a canonical correlation analysis between the set of organizational mechanisms and confidence in protecting knowledge from leakage. We enter all the organizational mechanisms as correlates in the RHS and both the measures of managers' confidence in protecting knowledge in the LHS. The results of this analysis are shown in Table 5. We find that there is a significant correlation of 0.70 between these two sets of variables.

INSERT TABLE 4 HERE

The loadings, suggest that both measures of confidence have a high loading on the co-variate measuring confidence in knowledge protection. On the RHS, we see that some of these co-variates have high loadings and others have much lower loadings. Specifically, headquarters control of the project has a very low loading of 0.29 and interdependence between locations has a medium loading of 0.54. All the other co-variates have high loadings on deployment of organizational mechanisms that protect trade secrets. This suggests that headquarters control of the project may not be an important factor in protecting knowledge when other mechanisms are also used together. Similarly, it is plausible that interdependence between locations is not relevant to projects that are predominantly performed from one location, or perhaps not deployed in all projects, though such projects may deploy other organizational mechanisms such as using specific assets and putting in place internal control for knowledge access.

The strength of the canonical correlation analysis is precisely in such instances - where multiple mechanisms may be used to achieve desired ends, with some of them being more important than others, and when the mechanisms themselves may have complex interrelations as complements and substitutes in achieving the desired results (Hair et al, 2009). In sum, this analysis suggests that deployment of the organizational mechanisms we argued for is associated with greater confidence in protecting knowledge. Further research is required, however, to understand the relative importance of each of these mechanisms and how they are inter-related. We also performed a canonical correlation between the organizational mechanisms and the set of project characteristics. The results again suggest that extent of deployment of the set of organizational mechanisms are correlated with performing projects that are a higher risk of knowledge leakage, and that more confident managers perform projects that have a higher inherent risk of knowledge leakage. These results are not reported for space constraints and are available from the authors. We performed a number of tests to check the robustness of our results which are not reported in this article on account of lack of space.

## DISCUSSION

We studied how firms limit or delay the leakage of their proprietary knowledge to competitors in the context of how managers of offshore captive centers of MNEs engaged in R&D and NPD activities protect their knowledge from leaking. This is an interesting context to study this question because the significant levels of R&D activity, the weak legal IP protection regimes, combined with the significant competitor presence, both domestic and multinational in in countries such as India and China make managing knowledge leakage a challenge for these centers.

Our empirical analysis and results provide some insights into understanding the mechanisms that organizations use to protect knowledge from leaking to competitors. The mechanisms we explore here are particularly relevant when the leakage of knowledge happens through the mobility of employees. Our results show that a set of mechanisms related to how a firm configures, manages and controls its R&D or NPD projects is positively associated with a manager's confidence in protecting its knowledge from leakage. These mechanisms include 'configuring projects' such that innovative activities are distributed across several locations, the activities involved are interdependent in nature and require investments in project/firm specific assets, 'managing projects' such that they require a high level of information sharing between different constituents and have internal controls for IP capture. We find that that greater usage of these mechanisms is not only linked positively to a firm's confidence in protecting its unpatented IP from leakage to rivals, but also associated with undertaking projects whose attributes are such that the risk of knowledge leakage is high. In other words, it seems firms are more willing to undertake projects that involve a higher risk of knowledge leakage if they have implemented the above mechanisms.

With the exception of Zhao (2006), previous research, to our knowledge, has not considered the influence of weak IP regimes in the offshore destinations on the offshoring of work that involves high end knowledge. We show that firms use several organizational mechanisms, apart from 'internal linkages' identified by Zhao (2006), that impede the leakage of valuable knowledge. Our findings thus contributes to our understanding of how MNCs manage to offshore destinations with a weak IPR by identifying organizational mechanisms that enable them to maintain secrecy of its knowledge, and also perhaps increase lead times for potential imitators.

Our results also indicate that while a ‘set of organizational’ mechanisms collectively helps in greater protection of IP/knowledge leakage, all of the mechanisms may not be equally important – some mechanisms such as asset specificity and involvement of HQ personnel in the project seem to be far more critical than others such as HQ control of the project. It is plausible that HQ control of the project ceases to be important when there is high involvement of HQ personnel in the project. Future research can delve much deeper to examine the differential impact of various organizational mechanisms.

Our analysis also helps uncover some subtle and counter-intuitive insights about the kind of projects firms might be willing to undertake even in offshoring of R&D and NPD activities. Generally one might believe that given the threat of knowledge leakage in offshore locations, managers might not be very willing to offshore projects that are more prone to IP leakage – but we find that is not always the case. High levels of deployment of some of the organizational mechanisms we have described increases managers’ confidence in their ability to prevent or minimize leakage of unpatented knowledge in their projects, which in turn enables them to take on projects that exhibit greater risk of IP leakage, such as those that are not firm specific but generally valuable even to competitors, and those that use significant levels of codified knowledge. This finding is critical because it not only helps understand what firms can do to minimize the leakage of valuable but unpatented knowhow, but also then sheds light on how firms can even potentially undertake knowledge intensive projects in distributed settings without the fear of easily losing the associated knowhow to rivals.

Our results also inform the larger literature on how firms appropriate value from innovation. Empirical research on this topic has overwhelmingly used patent data, even when they study non-patent based mechanisms such as secrecy, lead times or complementary assets,

perhaps because patent data is easily available to researchers (see Jones et al, 2013). However, as authors routinely point out in their limitations sections, using such data has some disadvantages, since not all valuable knowledge available to a firm are patented (Cohen et al, 2000). Far from being random, patent data imposes specific kinds of bias, such as ignoring tacit, hard to articulate, nascent and inchoate knowledge and innovations that may be obvious, though non-trivial extensions of prior art, all of which can be valuable to firms (Liebeskind, 1996). Cohen et al (2000) also point out the wide variation across sectors in their reliance on patenting to protect their IP. Mansfield et al (1981) point out that firms routinely imitate other firms patented knowledge by working around them, though imitation times and costs vary widely. However, there is a consensus that limiting leakage of valuable knowledge to competitors is important for firms to appropriate rents from such knowledge (Winter, 2006).

Our results build on the notion of ‘isolating mechanisms’ (Rumelt, 1982) that enable a firm to reduce imitation of its resources and capabilities. In terms of knowledge assets, we significantly add to the set of isolating mechanisms that firms can use apart from property rights conferred by patent rights and those that arise from the nature of knowledge itself, such as knowledge that is uniquely valuable to a firm, perhaps because it is tied to the firm’s strategy or its complementary assets (Teece, 1986; Helfat, 1994; Wang and Chen, 2010). We argue that when it comes to knowledge assets, organizational mechanisms discussed above can act as isolation mechanisms. Our work thus provides some empirical traction to and some additional insights to the theoretical arguments of Liebeskind (1996; 1997). In this way, our work complements and enriches this concept of ‘value appropriation as an organizational capability’ (Reitzig and Puranam, 2009) by outlining organizational processes that enable protection of

unpatented knowledge in firms – and thus provide a more comprehensive perspective on what such a capability might entail.

We should note that we focused on organizational mechanisms rather than HR type mechanisms such as salaries and bonuses in understanding how firms can protect their knowledge for two reasons. First, how to reduce employee mobility by increasing employee satisfaction has been studied previously in the HR literature (cf: Olander and Hurmelinna-Laukkanen, 2015; Kacmar et al, 2006; Dalton and Todor, 1982). Second, these practices still rely on competitors not outmatching the firm's offers. Organizational mechanisms on the other hand are likely to operate on the knowledge assets themselves, rendering these assets (partially) immobile.

Our work points to the importance of keeping in mind value appropriation when considering strategies for value creation. Our research suggests that managers adopt several mechanisms, such as high interdependence between geographies, internal controls of knowledge, and high asset specificity, even though these mechanisms are more likely to impede knowledge creation. However, our research suggests that implementing collocation, adopting industry standard protocols and modularity, though beneficial for knowledge creation, also makes it much more likely that such knowledge will leak to competitors. In this context, we interestingly find that managers, instead of treating system dependence or social complexity as a property of knowledge, actively try to shape it. Many of our mechanisms are aimed at perhaps artificially increasing system dependence and social complexity, in the hope of making knowledge less leaky, though perhaps at the cost of also making it less useful to the firm. This suggests an inherent trade-off regarding how to organize knowledge intensive activities for value creation versus value appropriation, which has not received much scrutiny in scholarly work. More work

remains either rooted in a value creation or appropriability framework, without considering how these influences and interact with each other. This is an important direction for future work.

*Limitations:* As with all work, ours is also subject to several limitations. The first limitation arises from the nature of our data, which is obtained from a handful of interviews and from cross-sectional survey. The cross-sectional nature of our data limits our ability to empirically establish causality among the relationships studied. However, our empirical approach was motivated by our qualitative study. In a survey, we find plausible support for what the managers were telling us regarding how to protect knowledge. Though the survey establishes correlations among these relationships, we derive our causal inferences from our interviews. Since we interviewed several managers in sectors that significantly offshore R&D and NPD activity, we have some confidence that the relationships we identify are causally related.

The measures we use in this study are perceptual measures, and although the scales were validated and deemed reliable, the results could be made more robust if triangulated with objective data on the nature of projects and on the extent of actual leakage. However, such data are notoriously hard to obtain. We have done the usual tests for common method bias in our data. In this respect, our study is similar to many published studies on offshoring that rely on survey data (Mani et al, 2014; Lewin et al, 2009; Larsen et al, 2012).

Second, the nature of the context we studied may color our findings, especially when generalizing to how firm protect their trade secrets. Though the offshoring of R&D is a setting in which firms are particularly reliant on organizational mechanisms to protect their knowledge, we may be missing some mechanisms that are observed only in smaller firms from a single location, and we may be identifying mechanisms that are unique to only offshoring to India. Even though our sample consists of firms with significant heterogeneity in size, age and sector, we may not be

truly identifying all the mechanisms firms use to protect their knowledge assets. Future research across a variety of settings, especially in clusters, can make more generalizable claims.

Finally, as we discussed earlier, our data is not substantive enough to establish inter-relationships between the mechanisms we identified. We do not know how prevalent these mechanisms are across different kinds of firms and in different sectors, and their relative strengths, whether they are related to specific kinds of knowledge, and if they are complements or substitutes. This is an excellent topic for future research.

Despite these limitations, we believe our paper contributes in a significant way to the understudied topic of understanding of the organizational mechanisms that firms can use to protect their knowledge assets from leakage to competitors.

**TABLE 1 – MEASURES**

Unless indicated, all scales were measured using the following format: Please indicate the extent to which you agree with the following statements (1-7 scale: disagree–agree):

**DV: Confidence in Trade Secret Protection**

Items	Not Confident (1-5)	Confident (6-7)
Secrets are an effective way of protecting our IP	34 (24%)	108 (76%)
We have put in place effective safeguards to protect our knowledge if an employee leaves the organization	38 (27%)	104 (73%)

**DV: Characteristics that increase knowledge leakage risk of the project**

<b>1. Generality of the (expected) innovation</b>
If a competitor could access this knowledge, our competitive advantage could be lost.
<b>2. Usage of prior firm internal knowledge</b>
This project involves substantial level of knowledge that is proprietary to our company.
<b>3. Radicalness of the (expected) innovation</b>
The output innovation of this project represents a major technological advance.
<b>4. Usage of codified knowledge (2 items; alpha: 0.77)</b>
(1) We had extensive documentation that described all the critical parts of this project; (2) Most of the training required to work in this project was obtained from our manuals.

**IV: Organizational mechanisms used to protect knowledge from leakage**

<b>1. Involvement of headquarters personnel (2 items, alpha: 0.87)</b>
(1) IP concerns determine the level of involvement of HQ scientists in this project; (2) IP concerns determine the level of involvement of HQ managers in this project
<b>2. Interdependence (2 items, alpha: 0.91)</b>
(1) Changes to the work approach or direction in other locations led to changes in work on the project in our location; (2) There was frequent need to talk to personnel in other locations about their work on the project so we could adjust our direction.
<b>3. Project Asset specificity (5 items, alpha: 0.86)</b>
(1) This project requires investments in skills that are not easily redeployable in other projects; (2) This project requires investments in equipment/capital that are not easily redeployable in other projects; (3) This project requires investments in software and similar technologies that are not easily redeployable in other projects; (4) Vendors performing this project need to be collocated with us in order to perform effectively; (5) Vendors have to invest in routines and procedures customized to your company in order to work effectively.
<b>4. Headquarters Control of Project (3 items, alpha: 0.91)</b>
Please indicate who makes decisions in your center regarding (1-5 scale: subsidiary fully autonomous – complete control by HQ):
(1) Product design; (2) Documentation standards; (3) Frequency and format of reports for R&D results

<b>5. Extent of information sharing (6 items, alpha: 0.84)<sup>1</sup></b>
(To what extent were the following project information shared between your center and other locations; 1-not shared at all to 7-shared very frequently):
(1) Quality information; (2) Schedule and delivery information; (3) Detailed cost information; (4) Marketing information; (5) Proprietary technical information; (6) Design information
<b>6. Internal controls for IP capture (2 items, alpha: 0.83)</b>
(1) Implement internal controls such that only very selected few have access to all information relating to an innovation; (2) Implement strong mechanisms for knowledge capture.

**Table 2:** Correlation Table

		1	2	3	4	5	6	7	8
1	Confidence	1.00							
2	Project Risk	0.71	1.00						
3	HQ involvement	0.61	0.66	1.00					
4	Interdependence	0.39	0.35	0.46	1.00				
5	Asset Specificity	0.61	0.66	0.69	0.52	1.00			
6	HQ Control	0.21	0.22	0.26	0.20	0.35	1.00		
7	Information Sharing	0.48	0.43	0.35	0.43	0.58	0.19	1.00	
8	Internal controls	0.57	0.64	0.74	0.45	0.72	0.36	0.35	1.00

All coefficients are significant at the  $p < 0.05$  level.

<sup>1</sup> Our results are qualitatively similar if we redefine this scale to only include items 1, 3, 5 and 6.

**Table 3a:** Difference in means on usage of suggested organizational mechanisms that reduce the risk trade secret leakage among managers who are more confident of protecting their IP versus managers who are less confident of protecting their IP.

	High Confidence	Low Confidence	Difference†
Involvement of headquarters personnel	0.12	-1.02	1.14 (0.21)***
Interdependence between project locations	0.04	-0.77	0.81 (0.21)***
Projects requiring investments in specific assets	0.03	-0.80	0.83(0.13)***
Headquarters control of project	0.08	-0.32	0.40 (0.18)**
Extent of information sharing	0.09	-0.82	0.91 (0.20)***
Internal controls for IP capture	0.13	-0.79	0.92 (0.19)***

†Standard errors in parentheses; \*\*\*, \*\* and \* are significant at  $p < 0.01$ ,  $p < 0.05$  and  $p < 0.1$  respectively. The variables are standardized in these tests. The low confidence groups have a negative mean for implementation because they are lower than the mean for the entire sample.

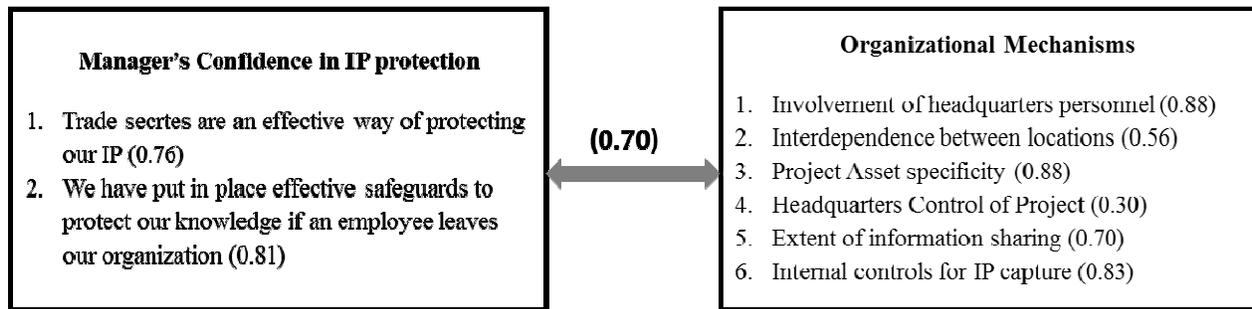
**Table 3b:** Difference in means on performing projects whose knowledge is at a higher risk of IP leakage among managers who are more confident of protecting their IP versus managers who are less confident of protecting their IP.

	High Confidence	Low Confidence	Difference†
Innovation is generally valuable to all firms (not firm-specific)	0.05	-0.69	0.74(0.21)***
Extent of usage of firm's prior knowledge in the project	0.24	-1.0	1.24 (0.19)***
Radicalness of expected innovation	0.24	-0.86	1.10 (0.20)***
Usage of more codified knowledge in the project	0.12	-0.75	0.88 (0.20)***

†Standard errors in parentheses; \*\*\*, \*\* and \* are significant at  $p < 0.01$ ,  $p < 0.05$  and  $p < 0.1$  respectively. The variables are standardized in these tests. The low confidence groups have a negative mean for these project characteristics because they are lower than the mean for the entire sample.

**Table 4: Canonical Correlation**

(Loadings of individual elements on to respective canonical covariates shown in parentheses)



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<sup>2</sup>[http://www.economistinsights.com/sites/default/files/downloads/Coming%20of%20age%20Asias%20evolving%20RnD%20landscape\\_WEB.pdf](http://www.economistinsights.com/sites/default/files/downloads/Coming%20of%20age%20Asias%20evolving%20RnD%20landscape_WEB.pdf)