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Barriers to Open Innovation: Case China

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Abstract

The notion of open innovation suggests that firms can boost their innovative performance by both acquiring knowledge from outside the company and deploying external paths to market for commercialization of non-core technologies. As innovations emerge increasingly from interorganisational cooperation, the background for such cooperation can also have an impact on the involvement of companies into open innovation processes. Thereby this paper proposes to analyze the barriers towards open innovation from three different aspects, such as internal firms' environment, institutional factors or innovation system and cultural background. Our findings indicate that economic systems and institutions (in particular the protection of IPRs) may have large effects on the behaviour of firms with respect to their engagement in open innovation practices. On the other hand, our results also suggest that the importance of appropriability regime may differ in the buy and sell sides of knowledge, and finally we demonstrate the influence of peculiarities of national cultures upon the adoption of certain elements of open innovation model.

Keywords: Open innovation; markets for technology; intellectual property rights; organizational culture.

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Introduction

Business cannot avoid the influence of the recent change in the operating environment: competition has become intensified, knowledge diffusion is becoming increasingly broad and fast, amounts of R&D investments growth rapidly and at the same time the life-cycles of products and technologies are shortening. In order to optimize product development and fit it into shortened time frames, the firms need to be able to utilize multiple knowledge sources, and apply new approaches to management of intangible assets. (Miller and Langdon, 1999)

The concept of open innovation suggests, among other things, that firms can enhance their innovative performance by acquiring knowledge from external sources, as well as benefit financially by using external paths to market for internally generated technologies that do not fit the current business model (Chesbrough, 2003; Gassmann and Enkel, 2004). An open innovation model also emphasizes that innovations emerge increasingly as a result of inter-organizational cooperation, which means that the concept is relevant not only at a company level, but also at the regional and country levels. When examining implementation of open innovation in a regional context, however, it is important to notice that economic systems and institutions in different regions and countries differ in their support for open innovation practices (Nelson 1993). For example, the strength of IPR protection varies between countries, which may significantly affect firms' desire to buy, sell or collaboratively create new knowledge. Moreover, countries differ in various structural and cultural issues that may affect firms' willingness to use open innovation practices. It is therefore of great interest to identify which factors have the most significant effect on knowledge flows between organizations within a given region or country.

In this paper, we will examine implementation of open innovation in Chinese firms. In particular, we focus on the relative importance of different institutional, structural and cultural factors that may affect the use of open innovation practices in China. Hence, we view the barriers and motivators to adoption of open innovation practices from three different levels of analysis: (1) internal factors of the firm, such as e.g. R&D intensity and availability of surplus technologies; (2) innovation system level as for instance influence of innovation policies and public funding on firm's involvement into open innovation processes and (3) cultural level, i.e. certain features of national and organizational culture creating an attitude towards the use of open innovation practices within the company.

The paper is structured as follow: first, the theoretical background on open innovation is presented and hypotheses introduced, followed by the overview of national innovation system of China as the important environment influencing the adoption of open innovation practices; next the data and methodology are described and the paper concludes with the results of analysis.

Theoretical Background on Open Innovation

The notion of "open innovation" was first proposed by Chesbrough (2003 a,b) and has quickly gained the interest of both researchers and practitioners. The model stands for the way of innovation management when company provide internally generated knowledge for the market and external knowledge to flow in for maximizing the benefit of the company. It is also described as "both a set of practices for profiting from innovation and a cognitive model for creating, interpreting and researching those practices" (West et al, 2006, p. 286).

Open innovation can be described in terms of combination of two differently directed processes: inbound and outbound. Inbound process stands for in-sourcing external knowledge through licensing in, spinning in, acquisition (in order to get valuable technology, personnel etc.) and collaboration alongside value chain. The latter can be illustrated at the example of Procter & Gamble, who cooperate with customers, suppliers, competitors and other institutions to pursue ideas, which can be utilized in the process of new product development (Huston and Sakkab, 2006). Outbound process stands for external utilization of internal knowledge. The 'surplus' of research, not fitting to current business model, used to sit on the shelf within close innovation model (Chesbrough, 2003). This means that the company had to fiercely protect this surplus by intellectual property rights in order not to lose it (as even the employees of the company could utilize the surplus for establishing own business with venture money). Open innovation approach states that the surplus can be used for realizing some potential value through selling it away to the other company, which could utilize it better within its resource base and business model.

As described by Chesbrough (2003a,b) the opportunities for sourcing the external knowledge have increased significantly and the outside-in process, or more specifically knowledge acquisition has been widely studied in the academia (Granstrand et al. 1992; Kurokawa 1997; Veuglers and Cassiman 1999), as well as practiced by the business (e.g. Procter & Gamble's Connect and Develop case (see Chesbrough et al. 2006).While the acquisition of external technologies is nowadays commonplace, the exploitation of technologies and intellectual property (IP) outside the company (outbound open innovation as defined by Chesbrough (2003) and Gassmann and Enkel (2004)) is still observed infrequently (Athreye and Cantwell 2007; Mendi 2007).

According to open innovation model, innovations emerge increasingly as a result of inter-organizational cooperation; hence, the environment of this cooperation attracts attention to the national and regional systems of innovation. The national system of innovation (NSI) refers to a framework that aims to explain the differences in innovation performance of nations through differences in their institutional support for such innovation (Lundvall, 1992; Nelson, 1993). The NSI framework stresses the idea that the flow of knowledge (and technologies) between individuals and organizational actors is key to the innovative process. While there are numerous factors that affect these knowledge flows, among the most important is the existence of various "institutions". These include, for instance, a nation's intellectual property (IP) policy, which by determining the formal appropriability of innovations (through patenting and other laws) has a significant effect on the development and diffusion of knowledge. The set of institutions also provides the framework within which innovation policies (concerning, e.g., public funding of research and development) are formed and implemented (Metcalfe, 1995).

While formal institutions to a considerable degree shape the external relationships among key actors (firms, universities, public research institutes, etc.) in the NSI, there are also structural factors that affect the flows of knowledge between firms. In particular, the industry/market structure affects, and is dependent upon, firms' rent appropriation strategies (e.g., the use of patents and technology licensing; Arora, 1997) and therefore also the knowledge flows between them. Indeed, diverse industries may represent distinct "systems" of innovation even within a nation (Nelson and Rosenberg, 1993). In the cross-country comparisons of NSIs, it is therefore important to take industry specific factors into account as well.

One of the key determinants of Open Innovation practices is the investments made by companies in research and development (R&D) activities, as well as the environmental conditions that foster the development of capabilities and on a regional and national level (Porter and Stern, 2001). On one hand, firms need to invest into R&D for development of new products and offering them to market faster than competitors. Additionally, creating knowledge assets by intensive R&D often results in surplus technologies available for sale to gain additional profit to reinvest in R&D which in its turn bring to producing new portion of surplus technologies. Active R&D activities of the company would also foster the development of high absorptive capacity (Cohen and Levinthal 1990) and hence the ability of firm to insource the external knowledge would be higher. On the other hand, intensive R&D, as it used to be in the closed innovation model, would supply companies with a lot of product ideas and new technologies, and the need for acquiring the external knowledge would decrease. For two of very first cases of open innovation – IBM and P&G studied by Chesbrough (2003) the adoption of open innovation practices came as a consequence of layoffs in R&D departments and the need to find new sources of product ideas and technologies. Hence, the intensive R&D investments may create a barrier to company openness:

> *Hypothesis 1a: Firms with high level of R&D intensity are less eager to embrace inbound open innovation.*
>
> *Hypothesis 1b: Firms with high level of R&D intensity tend to produce more surplus technologies*

Companies that operate in open innovation environment do not have to rely only on internal funding for R&D, and since firms do exist in regional systems the open innovation benefits are best achieved in regional clusters. This fact was explained yet by economists (Romer 1987; Krugman 1991) pointing out the benefits of geographical proximity and regional concentration of network partners due to reduced production and transport costs and lower costs of accessing information locally. Hence, the role of regional systems for fostering innovation activation and open innovation interactions of the firms is increasingly

high, especially for small and middle-sized companies. The regional innovation system is enabled by knowledge exchanges among different actors of regional network, including governmental institutions. The nature of such knowledge exchange is in large scale defined by national policies enabling the creation and incorporation of innovation within a national economy. The studies on national innovation systems (NIS) focus on the role of nation-state in supporting the innovation activities of local enterprises and to large extent on the government-sponsored research. Such state-financed research creates benefits for both the direct recipient and related firms through the spillover effects (Nelson 1993; Bresnahan and Malerba 1999). Additionally, researchers have examined the additionality effects of public funding (Buisseret et al., 1995; Davenport et al., 1998) meaning that public funding motivates company to invest more of its own fund into R&D (since the prerequisite to obtaining the public finance is a certain amount of own capital input to the project). As we have already claimed the increase in amount of R&D funding has a positive effect on the amount of surplus technologies produced by the company. Hence:

Hypothesis 2a: Public funding increases R&D output and amount of surplus technologies

However, alongside with public finding certain restrictions come in act. The national policies on innovation differ from country to country, however the general feature of every additional funding is the concern of who owns the result. A general intellectual property rights (IPR) system and particularly strong, established rules for the protection of intellectual property are referred as appropriability regime in Teece's, 1986. While a reasonable assumption is that under a weak appropriability regime firms are encouraged to protect their innovations, and are thus less inclined to share their internally generated knowledge with others, even the strong appropriability regime cannot endure the ownership of the technology made with the public finance. The national policies on innovation are the ones regulating the matters of ownership of research results (Braczyk et al., 1998); however, if the ownership of direct research results can be insured by strong appropriability regimes, the ownership of research surplus which emerged from publicly funded research is still undefined issue for most innovation policies. This leads to the contradictory to hypothesis 2a assumption that:

Hypothesis 2b: Firms are less inclined to sell intellectual property and technologies that result from publicly funded research projects

Another barrier arising from IPR area relates to the costs of IP protection and the procedure of claiming intellectual property. Strong IPR protection encourages disclosure and promotes efficient trade on markets for technology (Chesbrough et al. 2006). Weak appropriability implies widespread existence of knowledge externalities (Malerba and Orsenigo 1993). Consequently, within weak appropriability regime, each individual firm will have less incentive to conduct in-house R&D; hence the amount of research surplus would decrease as well. Weak IPR protection in the end may lead to the overall rate of private sector R&D decreasing below the levels needed to sustain long-term private returns from innovation, and may therefore necessitate public support for in-house R&D. Hence, avoiding the above mentioned externalities through strong protection of formal IP is supposed to increase the willingness of companies to develop own technologies in-house. A tight IP regime does mean that it is easier for firms to acquire technologies in the marketplace; and similarly easier to sell or license own technology. IP creates a platform for "commodification" and transfer of technology (Graham and Mowery 2004) and hence for collaboration within open innovation model. Hence, the involvement of companies into open innovation may depend on the strength of IRP protection and associated with it costs and formal arrangement:

Hypothesis 3: The greater the complexity and cost of IPR protection, the less likely firms will engage in open innovation.

The third level of analysis of barriers to open innovation deals with national and organizational cultures. Some researchers (e.g. Takada and Jain, 1991; Straub, 1994; Dwyer et al, 2005) suggest culture has an influence on the diffusion of innovations. The five dimension index scores of culture offered by Hofstede (1991, 2001) explains behavior of individuals and organizations by their cultural peculiarities, measured through collectivism versus individualism, level of power distance, uncertainty avoidance, masculinity or femininity and long- or short-term orientation. In case of China, collectivism ranking is high against individualism (Hofstede 1991, 2001) which should have a positive influence on open innovation since

collectivistic culture is more prone to form cooperative ventures. Power distance is ranking high in China which means that the governance is very much centralized. This creates the barrier to research surplus and new ideas circulating within organization. Additionally, China is characterized by high level of uncertainty avoidance, which means that Chinese are less risk-taking. Compared with old brands, new products are more risky because the function and performance are more ambiguous. In this case, people from countries characterized by strong uncertainty avoidance are less innovative than people from countries characterized by weak uncertainty avoidance.

China has a long-term orientation culture, and it scores the highest of all national cultures in the long-term orientation score. This is of the highest important for open innovation practices adoption, since people in long-term orientated culture focus on saving (Hofstede 2001). Hence the habit of shelving technology comes from long-term orientation as well as the resistance to sell the research surplus - Not Sold Here syndrome – can be connected to the long cultural tradition of waiting to get the reward in long-term; when the resistance to sell out the technology will emerge from believe that it will be useful to the company in long-run. Since, the long-term orientation is the strongest feature of Chinese culture (Hofstede 2001), we claim that it has an impact on development of strong Not Sold Here syndrome and utilization of outbound open innovation.

> *Hypothesis 4: The high cultural long-term orientation of the firms causes strong Not Sold Here syndrome and decreases the tendency to utilize outbound open innovation.*

Innovation System in China

Civil research and development (R&D) activities in China were for decades limited in scale, scope and depth and separated from production. In the early phase of the economic transformation prompted by the "open door" policy, new knowledge and innovation still played a modest and largely passive role in economic growth and were mainly embodied in the growing capital stock, including the first wave of foreign investment. (OECD 2007)

The origin of the Chinese innovation system can be traced back to the mid-1980s (Gu and Lundvall 2006) when reform of the science and technology system was included in the broader agenda of economic reforms. Science and technology industrial parks, university science parks and technology business incubators were started as new infrastructures to encourage industry-science relationships, and spin-offs from public research organizations started to fill the gap. The maturing of the system was accelerated in the 1990s through the combined effect of continued international opening (e.g. accession to the World Trade Organization in 2001), improvement of corporate governance and key framework conditions for innovation (e.g. protection of intellectual property rights) as well as further reforms of the university and public research sectors (OECD 2007).

By the turn of the century, a combination of experimental national policies in special zones, bottom-up initiatives supported by regional and local authorities, and top-down systemic reforms had created a Chinese NIS under construction.

As a result of external pressures and to meet its own economic objectives, China has been moving its intellectual property rights (IPR) regime closer to those found in many more developed nations. As China's economy grows, its transition from manufacturing-based to knowledge-based production, more comprehensive laws, and more attention to enforcement have led to an increase in the number of IPR infringement cases being brought before the courts or taken up through China's administrative procedures. Allowing IP owners to recover their economic damages from infringers is an important component of a system for IPR protection. Properly determined, damage awards can serve as an effective deterrent to IPR violations and protect the incentives to innovate (Sepetys and Cox 2009). China has got a comprehensive IPR legislation system, basically in conformity with international norms, and standards: Trademark law (1982), Patent Law (1984), Copyright's law (1990), however the IRP infringements are still commonplace.

Data and Methodology

We test the validity of our hypotheses with data that comes from a recent international survey on open innovation practices. In the case of China, the data were collected through email and a paper survey, and also by phone in a few cases. Around 800 target companies for the survey were selected from the firms operating in the

Yunnan Province and of these 501 responded to the survey. The majority of the responding firms (69.5 percent, 348 firms) belong to the manufacturing sector, but the service sector also represents a significant industry segment among the respondent firms (16.8 percent, 84 firms). With regard to size (number of employees) and the level of R&D intensity (investments per revenue ratio) of the companies, the distributions are as follows:

Size (employees)	No.	%
Micro (< 10)	3	0,6
Small (< 50)	146	29,1
Medium-sized (50-250)	203	40,5
Large(> 250)	148	29,5
Not defined	1	0,2
Total	**501**	**100**

R&D intensity	No.	%
0 - 1,5 %	116	23,2
1,5 % - 3 %	198	39,5
3 % - 5 %	156	31,1
5 % - 10 %	30	6,0
10 % -	0	0,0
Not defined	1	0,2
Total	**501**	**100**

Table 1. The size distribution and R&D intensity of the respondent firms

The questionnaire was designed in a straightforward way to collect primarily factual information on basic firm demographics, practices with respect to the acquisition of external knowledge as well as the selling of internally generated knowledge into the external market, and, finally, practices and experiences regarding research collaboration with other firms and public institutions.

In order to test hypotheses 1a, 1b, 2a and 2b, we created two variables for measuring the firms' propensity to engage in inbound and outbound open innovation. More specifically, the survey responses to the following questions were converted into two binary variables ***Open Innovation In*** and ***Open Innovation Out***:

- How well does the in-house R&D of your company match with your technology requirements?
  - Completely
  - We sometimes acquire external technologies
  - The utilization of external technologies (and knowledge) is vital in our business

- To what extent your R&D results in new technologies or intellectual property that you are not able to utilize in your current businesses?
  - We have no such technologies
  - "Surplus" technologies emerge unavoidably, because only a part of emerging technologies can be commercialized
  - The development of technologies and intellectual property for external organizations is a central element in our business model

If respondents checked the option 'completely' in the first question, we set the value of ***Open Innovation In*** to 0 and 1 otherwise. Similarly, if the respondent indicated that they have no surplus technologies (the first option in the second question), we set the value of ***Open Innovation Out*** to 0 and 1 otherwise. Since these two dependent variables are dichotomous, we employ binary logit regression models to test our hypotheses.

For hypotheses 1a and 1b, we use ***R&D intensity*** as an explanatory variable (an ordinal scale with 5 levels). Furthermore, for hypotheses 2a and 2b, we created a binary explanatory variable ***Public funding*** indicating whether the firm has received public subsidies for its own R&D projects (if the respondent answered affirmatively to the corresponding question, the value is set to one, zero otherwise). Finally, we use two control variables in the regressions: a dummy variable ***Non-manufacturing*** (indicating that the firm does not belong to the manufacturing sector) and ***Size***, which is modeled as a

series of three dummy variables to reflect the employee-based size classes (see Table 1). Size classes include ***small*** (number of employees less than 50), ***medium*** and ***large***, with the small dummy being excluded from the regressions.

Results

First, with regard to the effect of a firm's R&D intensity on its propensity to engage in inbound and outbound open innovation, our regression results can be found in Table 2. We find that the coefficient for the main explanatory variable ***R&D intensity*** is statistically highly significant and has the expected sign in both models 1 and 2, which include ***Open Innovation In*** and ***Open Innovation Out*** as dependent variables, respectively. We can therefore conclude that the data supports both hypotheses 1a and 1b, i.e., the higher the level of a firm's R&D intensity, the less likely it will acquire external technologies and the more likely it will have surplus technologies to offer for other organizations. The results from the first two models also show that a firm's industry has an effect on its open innovation practices. That is, the surveyed companies that do not belong to the manufacturing sector seem to be more likely to engage in both inbound and outbound open innovation. Moreover, while a firm's size does not seem to influence its utilization of external technologies, the results suggest that smaller companies are more likely to have surplus technologies and/or develop technologies for other organizations. This finding is quite consistent with the assumption that small firms rarely possess all the needed complementary assets to commercialize an innovation and therefore must license or sell their technologies to larger companies.

	Dependent variables		
	Model 1 ***Open Innovation In***	Model 2 ***Open Innovation Out***	Model 3 ***Open Innovation Out***
constant	2,579 *** (0,408)	-3,676 *** (0,411)	-3,998 *** (0,441)
R&D intensity	-0,570 *** (0,148)	1,242 *** (0,153)	1,094 *** (0,157)
Public funding			1,060 *** (0,264)
Non-manufacturing	0,941 *** (0,307)	0,417 * (0,244)	0,626 ** (0,259)
Size medium	-0,161 (0,300)	-0,644 ** (0,276)	-0,547 * (0,284)
Size large	0,381 (0,343)	-0,919 *** (0,319)	-1,099 *** (0,331)
N	498	498	485
LR (χ^2 test)	27,965	89,635	105,746

(Standard errors in parentheses. * Significant at 0.1 level, ** significant at 0.05 level, *** significant at 0.01 level; two-tailed tests. All χ^2 tests significant at 0.01 level.)

Table 2. The results from logit regressions

In order to examine the effect of received public subsidies on the extent to which a firm's R&D activities result in surplus technologies and, consequently, it's propensity to engage in outbound open innovation, ***Public funding*** is added as an explanatory variable to the regression in the third model. In this model (see Table 2 for the results), the coefficient of ***Public funding*** has a positive sign and is statistically highly significant, which means that from the two competing hypotheses, 2a and 2b, the first is supported by the data. In other words, the output additionality effect clearly dominates the restrictive effect caused by a weak appropriability regime (the low level of intellectual property protection) in the surveyed Chinese companies.

Next we turn to the most important barriers that firms perceive when it comes to engaging in open innovation. In the questionnaire, two questions were included to assess the importance of various barriers to both the utilization of external technologies (inbound open innovation) and offering (selling) technologies to other organizations (outbound open innovation). In addition to a field in which the respondent could specify other barriers, four previously identified key barriers were suggested in both checkbox -type of questions. First, Table 3 presents the results with regard to the main barriers to the utilization of external technologies.

Barrier	No.	%
"Not Invented Here" [B11]	73	14,6
No adequate technologies on offer [B12]	288	57,5
Takes too much time/resources [B13]	141	28,1
Fear of losing own innovation ability [B14]	49	9,8
Other barriers [B15]	4	0,8

Table 3. The main barriers to inbound open innovation.

As one can see, the lack of desired technologies on offer is most frequently perceived as a barrier to inbound open innovation. This finding therefore clearly reflects the underdeveloped state of markets for technology in China. Moreover, while the costs of and time requirements for external technology acquisition are seen as important barriers less often, almost thirty percent of the respondents had checked this option. The "Not Invented Here" syndrome was seen as a major barrier by only about fifteen percent of the respondents, but the result still shows that cultural barriers play a role in firms' willingness to utilize external technologies.

An interesting question is to what extent the perception of different barriers depends on the level of a firm's 'openness'. The following Table 4 presents the distribution of answers to the same question for firms in which 1) in-house R&D completely matches technology requirements, 2) external technologies are sometimes acquired, and 3) utilization of external technologies is vital for the business. While it is obvious that the firms that do not utilize external technologies have not considered, and therefore do not report on, different barriers, it is somewhat surprising that the four main barriers are identified almost equally often by firms that sometimes acquire external technologies and firms for which the utilization of external technologies is vital. On the other hand, the fact that both those firms that report utilizing inbound open innovation only occasionally and those that are crucially dependent on it perceive the different barriers similarly clearly suggests that the above factors may have a significant negative effect on open innovation practices.

Barrier / level of openness	B11	B12	B13	B14	B15	**Total**
1 (N = 90)	0	1	0	0	0	**1**
2 (N = 220)	40	167	65	29	2	**303**
3 (N = 190)	33	120	76	20	2	**251**
Total	**73**	**288**	**141**	**49**	**4**	**555**

Table 4. The main barriers to inbound open innovation with respect to firms' 'openness' (N = number of responses)

The results concerning the main barriers to offering technologies outside are in turn presented in Table 5. While the suggested factors are in general less often perceived as major barriers in the surveyed firms (as compared to the barriers to inbound open innovation), almost one fifth of the respondents indicated that the complexity of intellectual property rights (fear of infringements) has a negative effect on the firm's propensity to engage in outbound open innovation. This finding therefore provides support for our hypothesis 3. In other words, the complicated IPR protection issues create a barrier for firms to utilize open innovation practices.

Moreover, the fact that "Not Sold Here" syndrome is perceived as a major barrier to outbound open innovation by over ten percent of the respondents clearly supports our hypothesis 4, according to which cultural peculiarities impose a barrier towards outbound open innovation in Chinese firms creating protective attitudes towards the external exploitation of knowledge (expressed through Not Sold Here syndrome).

Finally, considering that the lack of desired technologies on offer is perceived as a major barrier to inbound open innovation, it is quite expected that the difficulty of finding buyers for technologies is a barrier to outbound open innovation. That is, both of these barriers result partly from the lack of marketplaces for technologies in China.

Barrier	No.	%
"Not Sold Here" [B21]	54	10,8
Complexity of IPR, fear of infringements [B22]	94	18,8
The difficulty of finding buyers [B23]	49	9,8
Lack of marketplaces for technologies [B24]	21	4,2
Other barriers [B25]	2	0,4

Table 5. The main barriers to outbound open innovation

If we again examine the importance of the above barriers with respect to firms' openness (see Table 6), we can see that the complexity of intellectual property rights is the most important barrier to outbound open innovation (relative to other barriers) especially among the firms for which the development of technologies for other organizations is core to their business model (3). In fact, 41 of the 48 respondents considered this factor to be a major barrier to the external exploitation of knowledge. On the other hand, in firms in which surplus technologies emerge unavoidably (2), three of the most often identified barriers to outbound open innovation are more evenly distributed among the answers.

Barrier / level of openness	B21	B22	B23	B24	B25	**Total**
1 (N = 374)	0	0	0	0	0	**0**
2 (N = 78)	40	53	35	15	0	**143**
3 (N = 48)	14	41	14	6	2	**77**
Total	**54**	**94**	**49**	**21**	**2**	**220**

Table 6. The main barriers to outbound open innovation with respect to firms' 'openness' (N = number of responses)

Taking all together, the results of the survey provide direct support for our hypotheses 1a, 1b and 2a, as well as indirect support for hypotheses 3 and 4. More specifically, of the various company level factors R&D intensity is inversely related to participation in inbound open innovation and directly related to participation in embracing outbound open innovation.

The effects of national level barriers (the firm's external environment), such as weak intellectual property protection and the complexity of intellectual property rights, in turn hinder the involvement of firms into open innovation practices. It was also found that public subsidies have a positive (additionality) effect on firms' R&D output, which may lead to their increased propensity to engage in outbound open innovation activities despite the weak appropriability regime often associated with publicly funded projects. Moreover, the underdeveloped state of markets for technology forms a barrier to open innovation practices in China.

Cultural factors explain certain attitudes towards openness of the firm as e.g. "Not Sold Here" syndrome can be explained by strong long-term orientation of Chinese culture and it creates an important barrier to outbound open innovation. Hence, it can be summarized that Chinese firms have protective attitudes towards the external exploitation of knowledge resulting from the cultural peculiarities.

Conclusions

Our findings indicate that economic systems and institutions (in particular the protection of IPRs) may have large effects on the behavior of firms with respect to their engagement in open innovation practices. On the other hand, since our results also suggest that the importance of appropriability regime may differ in the buy and sell sides of knowledge, the effects of property rights protection and its relationship to other structural issues ought to be more fully explored in future research.

IPR protection can promote innovation and economic development, through attracting FDI and strengthening incentives to innovate by domestic firms. The coherence between IPR and other policies and among the various entities involved in development and implementation of IPR policies is important. There is a great potential benefit for China from developing and exploiting intellectual property as part of its economic development strategy based on technological upgrading, and integration into the world economy.

We have claimed in this paper that the internal factors in the companies are influencing the adoption of open innovation alongside with institutional and cultural factors. However, to confirm the strong influence of latter the cross-cultural comparison might be considered as a direction of further research as well as the comparison of national systems of China and some developed countries.

One of the major limitations to the study is comes from the data collection, as only one region of China was studied and taking into account the possible differences in economic development between different regions of China, we cannot generalize all results to the whole country. However, such aspect as national culture and IPR issues (at the level of legislation and national policies) is similar across the whole country.

Overall this paper is relevant not only for academics, but also for policy makers interested in fostering innovativeness in their domains. That is, the development of a more supportive environment for open innovation (an "open innovation system") should be a highly important goal in regional and national innovation policies.

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