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Institutional regime shift in intellectual property rights and innovation strategies of firms in China

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INSTITUTIONAL REGIME SHIFT IN INTELLECTUAL PROPERTY RIGHTS AND PATENTING STRATEGIES OF FIRMS IN CHINA

ABSTRACT

This study develops a new conceptual framework to understand the differential impact of formal institutional regime shift in intellectual property rights on the innovation and patenting strategies of Chinese and Western firms operating in China. We argue that compared with Western firms, Chinese firms will more likely resort to alternative informal practices that are deeply rooted in the traditional Chinese philosophies to safeguard their intellectual assets from expropriation. Moreover, the complex and ambiguous interdependence between institutional forces in China makes it more feasible for Chinese firms to adopt such informal approaches. Using the major China patent law reform of 2001 as a natural experiment, we find results consistent with our key arguments: With the strengthening of (a previously weak form of) patent protection, Chinese firms do not increase the adoption of such protection for their internationally valuable innovations as much as Western firms do. However, the difference becomes less salient in regions with more robust legal institutions that foster R&D and innovation, and when Western firms operate longer in China. This study advances our understanding of how institutions can shape the strategic innovative behaviors of Chinese and Western firms in the transitional economy of China.

INTRODUCTION

How institutions influence organizations' strategic choices, such as their innovation strategies, has long intrigued researchers. The economic activities of a society are usually embedded in its institutional settings, which include both formal and informal ones. As the "rules of the game in a society" (North, 1990: 3), formal institutions represent structures of codified rules and standards. Conversely, informal institutions are enduring systems of non-codified normative and cognitive understanding and socially constructed practices that shape interaction and coordination among individuals or organizations (North, 1990; Scott, 1995). As one of the most important formal legal institutions, the intellectual property rights (IPR) system (e.g., patent laws) facilitates firms' innovative activities by providing protection against expropriation, therefore increasing the incentive for firms to innovate (Levin, Klevorick, Nelson, & Winter, 1987; Nordhaus, 1969; Zhao, 2006). Previous studies indicate that the improved formal legal institutions for IPR in a host country affect the country's innovation positively through the increase in inward foreign direct investment (FDI) on research and development (R&D) (Khoury & Peng, 2011) and international technology transfer (Branstetter, Fisman, & Foley, 2006; Helpman, 1993) as well as the improvement in industrial development in host countries (Branstetter, Fisman, Foley, & Saggi, 2011). Some studies also found that innovative efforts vary among nations because of different national informal institutions and norms (e.g., Jones & Davis, 2000; Shane, 1995).

However, what has been underexplored in the literature is how innovative activities are influenced by the interaction between formal and informal institutions. In particular, the extant managerial literature has not explained well how the impact of the change in formal IPR protecting institutions on firms' innovative activities may be conditional on how firms are embedded in the informal institutions of a country. This issue is especially important for firms

operating in emerging or transitional economies that have been undergoing substantial transformation in both formal and informal institutions (Peng, 2003). Some studies also indicate that formal and informal institutions may be substitutive: the relative weakness and inefficiency of formal institutions tend to increase firms' reliance on informal institutions (Batjargal, Hitt, Tsui, Emlyon, Webb, & Miller, 2012; Holmes, Miller, Hitt, & Salmador, 2011; Webb, Tihanyi, Ireland, & Sirmon, 2009; Xin & Pearce, 1996). However, how this substitutive relationship between formal and informal institutions might influence a firm's adaptation to changes in formal institutions remains unclear. Moreover, this line of research has not explored the variation across firms operating in the same institutional environment in terms of their reliance on formal and informal institutions, leading to their different reactions to the changes in formal institutions.

In this paper, we aim to address these important gaps in the literature by examining the impact of an exogenous change in formal institutions in China on firms' innovative behaviors. In particular, we compare the differential responses between Chinese and Western firms in their patenting of internationally important technologies that originated from China before and after an exogenous shift in China's formal IPR regime. China implemented one of the most significant amendments in its IPR laws in 2001, after which its IPR legal framework has substantially improved and better converged with international IPR regulations. This exogenous "shock" provides an ideal context to unravel the differential effects of a formal institutional change on strategic responses of firms operating in China. We argue that Chinese firms tend to resolve conflicts associated with innovative activities by resorting to informal institutional norms and practices which are deeply influenced by traditional Chinese philosophies that emphasize the avoidance of direct conflict and respect for authority and relationships. The complex and ambiguous interdependence between institutional forces in China makes it more feasible for

Chinese firms to adopt such informal practices. By contrast, Western firms are generally more accustomed to and rely more on formal rules and regulations and are less embedded in China's informal institutional environment. As a result, all else equal, domestic Chinese firms may not be as responsive to changes in formal institutions (e.g., formal IPR laws) as are Western firms operating in China. We further establish that the difference in the adoption of the improved patent protection (as a result of the IPR reform) by Chinese and Western firms is less salient (i) when the technologies are developed in regions with higher de facto institutional quality for fostering R&D and innovation; and (ii) when Western firms have accumulated more local experiences as their operational age in China increases.

This study seeks to make the following contributions. First, we theoretically identify the underlying rationales for Chinese firms' lower sensitivity to formal institutional changes and how they may seek alternative protection against expropriation in innovation through informal institutional approaches and norms that deeply characterize the Chinese society and its transitional economy. By doing so, this study contributes to the growing literature that considers the interaction between formal and informal institutions in influencing entrepreneurial activities and investment choices in developing countries (e.g., Batjargal et al., 2012; Hitt, Ahlstrom, Dacin, Levitas, & Svobodina, 2004; Holmes et al., 2011; Tonoyan, Strohmeyer, Habib, & Perlitz, 2010). This study also enriches our understanding of the substitutive effects between formal and informal institutions (e.g., Batjargal et al., 2012; Xin & Pearce, 1996) by providing detailed argument using the context of China on how such substitutive effect may constrain the effectiveness of a formal institutional change (in IPR), leading firms to adopt different innovation strategies.

Second, we provide a methodological contribution to the literature, by conducting a comparative research on innovations produced by firms from different countries. In particular, we focus on "transnational" patent, which is the patenting of the same invention by the same firm across more than one country, to control for the quality and value of such inventions patented by these firms across different countries. Such internationally important and valuable patented intellectual assets are not only of critical strategic importance to firms facing global competition but also provide a common platform for comparing the patenting behaviors of Western and domestic Chinese firms in China.

Furthermore, whereas previous research focused on variation in institutional environment across countries (e.g., Batjargal et al., 2012; Hitt et al., 2004), we examine the temporal and spatial effects of institutional change in China by exploiting a major, top-down IPR law reform in China as a natural experiment. This natural experiment setting, together with appropriate controls, can help mitigate concerns of reverse causality and endogeneity that have plagued many previous strategy studies in this area.

THEORY AND HYPOTHESES DEVELOPMENT

Institutions are the "rules of the game" in a society as well as the social structures that create, embody, and enforce these rules (North, 1990). They both facilitate and constrain human interaction. Formal institutions represent structures of codified or formally accepted rules and standards that shape the interaction among societal members, whereas informal institutions are enduring systems of traditions, societal norms and practices, and unwritten codes of conduct that reflect a socially constructed reality and define the shared expectations and acceptance of behaviors by members in a society (North, 1990; Scott, 1995). Institutions influence individual

or organizational decision making by constraining which choice and behavior are acceptable in the decision makers' cognitive and normative consideration (Peng, 2003; Scott, 1995).

Compared with informal institutions, formal institutions are more malleable because they can be consciously and purposely designed by human agency (e.g., through policy intervention) (Scott, 1995). Furthermore, the formal codified rules and standards reflect the motivation and collective actions of societal members seeking to solve economic or social problems that obstruct the ability to achieve goals deemed to be important (DiMaggio, 1988).

China's IPR Formal Institution, IPR Reforms, and Firms' Patenting Choices

The legal and regulatory protection of IPR, such as patent laws, is one of the most important aspects of formal institutions (Acemoglu, Johnson, & Robinson, 2001; Levin et al., 1987; Nordhaus, 1969; North, 1990). Compared with the developed Western countries that have long established clear and strong legal protection of IPR, developing or emerging economies such as China suffer from institutional inadequacies (Ginarte & Park, 1997). Although the Chinese patent system has been established for more than two decades (since 1985) and has undergone reforms, it is a relatively young system that requires further improvements compared with those in the developed Western nations.

Essentially, two types of patents are available from the State Intellectual Property Office (SIPO) of China for Western and Chinese firms developing their technologies and seeking formal IPR protection in China: invention patents and utility model patents.[1] Invention patent awarded by the SIPO is the strongest form of formal IPR protection in China. It is protected for 20 years from the date of filing, has the clearest property right protection (with little ambiguity)

[1] Following previous studies in innovation (e.g., Hall & Ziedonis, 2001; Jaffe & Trajtenberg, 2002), we exclude design patents from SIPO and USPTO in this study. Conceptually, design patents form a different class of intellectual property assets of very different nature and are less applicable to the technological innovations which we focus on in this study.

and is subject to both preliminary and substantive examination before it can be awarded. Alternatively, a firm can seek utility model patent protection for its technology in China from the SIPO. The utility model patent cannot be obtained in the U.S. because the United States Patent and Trademark Office (USPTO) does not issue such patent. Moreover, utility model patent in China lasts for 10 years and is generally perceived as a weaker or less clear form of IPR protection. It is especially suitable for new technical solutions such as those related to a product's shape, structure, or their combination. Thus the utility model patent is more closely related to an "improvement" patent, which is part of the UPSTO invention patent. No substantive examination is required for the utility model patent and therefore it is quicker and also slightly less expensive to be obtained than the invention patent. However, for the same reason, identical applications of utility model patents are more likely to be filed by more than one entity. Therefore, infringement is more likely to occur in the case of utility model patents.

Generally, although technologies filed for utility model patents can differ from those for invention patents, substantial overlaps in technology between the two types do exist. In fact, an innovation qualified for invention patents typically also qualifies for and may sometimes be filed for utility model patents instead. Therefore, to a large extent, firms can strategically decide to file for a utility model or an invention patent.

In anticipation of the accession to the World Trade Organization (WTO) in 2001, China adopted the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) in 2001 as part of its WTO obligations, in which its IPR standards were harmonized with international rules. The passage of the 2001 patent law reform provided new judicial protection and reduced the ambiguity specifically involving utility model patents, improving its application procedures and strengthening its enforcement and protection. In particular, a decision on the

patentability of a utility model patent may now be brought to the court for judicial review, and a search report obtained after a substantive examination may be required for utility model patents to reduce infringement. Under the new regime, even though utility model patents are still easier and somewhat less expensive to obtain relative to invention patents, their property rights, enforcement and review procedures have been substantially clarified and strengthened (e.g., Stembridge, 2010).

Therefore, it follows that as the regulations on the effectiveness of protection and examination of a previously weak form of IPR protection, that is, utility model patent, are clarified and strengthened, we should observe a general increase in the adoption of utility model patents by firms, including both Chinese and Western firms operating in China. The increase may arise from either a shift from innovations that may have been filed otherwise as invention patents or from those innovations that may not have been filed for any patents previously.

Hypothesis 1. The strengthening of a previously weak form of IPR protection (utility model patent) in China will lead to a general increase in the adoption of such IPR protection by firms.

Differential Responses of Chinese and Western Firms in China

Although both Chinese and Western firms operating in China may respond positively to the strengthening of China's patent law in 2001, the magnitude of change in their patenting behavior is expected to differ. We argue that the difference may originate from Chinese firms' behavioral tendency to avoid formal legal approaches for conflict resolution but to rely more on informal norm-based approaches. Moreover, the complex and ambiguous interdependence between institutional forces in China makes it more feasible for domestic Chinese firms to adopt such informal norms and practices.

Chinese firms' greater reliance on informal norms and practices are deeply rooted in the traditional Chinese philosophies of Taoism and Confucianism. In Taoism, there is no objective written rule about what the right conduct is. Instead, it emphasizes wuwei (action through non-action), naturalness, and spontaneity. According to the Tao Te Ching, the most influential Taoism text, "The Tao*"* – ultimate rules for human beings and society – *"*that can be told is not the eternal Tao*"*. It further says to "*let go of fixed plans and concepts, and the world will govern itself*". Moreover, in Taoism, open conflict and direct confrontation should be avoided whenever possible. "*When two great forces oppose each other, the victory will go to the one that knows how to yield.*" Rooted in Taoism, the Art of War by Sun Tzu is an exemplar of how such philosophical thinking shapes behavioral approach and strategy: "The supreme art of war is to subdue the enemy without fighting".

Similar to Taoism, Confucianism does not attach great importance to formal rules and regulations; instead, it places greater emphasis on social norms. In particular, Confucius developed a code of conduct as the basis of civil society; this code defines how a nation should be ruled and how human beings interact. In Confucianism, "rule by man" or renzhi is preferred to "rule by law" or fazhi. Confucianism's emphasis on renzhi establishes the role of authority and guanxi networks in governing the relationship between society members. Thus, respect for authority and relationships are considered important in implementing renzhi in China (e.g., Chai & Rhee, 2009; Xiao & Tsui, 2007).

Deeply influenced by these traditional philosophies, Chinese people and firms do not generally hold formal rules and regulations in the highest esteem. Thus, they often consider the formal legal systems for conflict resolution as the last resort because they see litigation in court as a form of direct confrontation that should be avoided. We suggest that Chinese firms rely less

on the formal confrontational legal approach to protect their intellectual assets but more on the informal approaches such as informal intervention by authorities, guanxi networks and practices deeply rooted in and shaped by such philosophical traditions.

Furthermore, the Chinese market is characterized by complex interdependence among multiple weak institutional forces, which further enhances the feasibility of conflict resolution through informal intervention by authorities and other informal norms and practices by Chinese firms. When there is a confluence of multiple weak and inefficient formal institutions (Batjargal et al., 2012; Ostrom, 2005), the institutions for rule making and enforcement become diffused, difficult to identify, and sometimes contradictory (Batjargal et al., 2012; Seo & Creed, 2002). This reduces the effectiveness of any institution. As a result, there is an increased need for informal coordination among institutions, typically through authorities or informal networks.

Particularly for IPR protection in China, there is significant interdependence among different institutions with diverse and sometimes conflicting goals and functions. In China, a patent infringement can often be resolved through either a judicial approach (e.g., lawsuit in court) or a bureaucratic approach (e.g., norm-based conflict settlement through patent offices in different levels of governments). During China's transition from planned to market-based economy, central and provincial governments play a substantial role in overseeing the operation of markets and the interaction between firms; therefore, government interference in firms is largely a norm and is expected by firms in China (Nee, 1989). Similarly, bureaucratic or administrative authorities (or xingzheng) in China often have substantive power in dealing with the infringement of IPR among firms (Liu, 1994). Moreover, since China's bureaucratic system is rather complex with different interdependent hierarchical levels, multiple bureaucratic units are often involved in resolving IPR-related conflicts. The presence of multiple complex,

interdependent departments and administrations induces a greater reliance of Chinese firms on informal institutions and hence provides more room for firms to seek norm-based, nonstandard bureaucratic approach and informal networks to coordinate among these interdependent agencies.

The following example of a patent infringement case illustrates the reliance on norm-based bureaucratic approach and the diverse goals and functions of agencies involved in resolving IPR-related conflicts. The main infringed patent is called Diesel Engine Manual Free Starter (SIPO utility model patent: CN2828351). The patent was applied in 2005 and granted in 2006 to a firm in Xinxiang, Henan province (SIPO, 2008a). When the firm sought the help from the city government's IPR official to protect its patent from infringement, the official discovered that many companies have already obtained sizable manufacturing scale by exploiting and infringing upon the patent. Under such circumstance, protecting the inventing firm's interest by implementing the patent law strictly could lead to potential closure of these infringing companies and dismissal of thousands of employees. Considering the economic implications and the diverse goals of interdependent agencies, the firm, with the help of Xinxiang city government, had adopted a norm-based approach to coordinate and liaise with different city- and county-level departments and administrations such as the local Patent Office, Police department, Administration of Industry and Commerce, and Bureau of Small and Medium Enterprises in order to resolve the infringement issue. The nonstandard solution adopted was the formation of a coalition chaired by the inventor and founder of the firm to allow usage to other companies while sharing technical and marketing resources and co-developing the technological product.

The confluence of multiple institutions further enhances the firm's reliance on informal networks (e.g., guanxi) or norms to better navigate in such complex environment (e.g., Batjargal et al., 2012). In a society that values adherence to social norms (Chen, 1995; Earley & Gibson,

1998; Xiao & Tsui, 2007), informal connections among firms may serve as deterrents to deviating behaviors in IPR infringement (e.g., Chai & Rhee, 2009). Informal networks can help to improve firm's access to bureaucratic officials for critical resources (Ayyagari et al., 2010; Chang & Wu, 2010; Xin & Pearce, 1996) or to reduce institutional uncertainties in norm-based bureaucratic interventions (Batjargal, 2010; Batjargal et al., 2012). In the case of IPR-related disputes, firms' informal connections to government officials can facilitate bureaucratic arbitration through negotiation and resolution of IPR conflicts among disputing firms outside the courts without undertaking formal litigation procedures.

In sum, we postulate that as Chinese firms are more embedded in informal institutions in China and are more accustomed to "rule by man" rather than "rule by law", they rely more on informal norm-based approaches instead of formal legal protection of their intellectual property assets against expropriation. In fact, less than 10% of most Chinese firms' significant "technological achievements" actually end up as patents despite encouragement from the local governments to apply for patent protection (SIPO, 2008b). Furthermore, the diffused and interdependent institutions in rule making and enforcement give more leeway for firms to respond to formal rules and reinforce the use of informal networks or practices. Therefore, even with an improvement in the IPR laws (and clearer property rights), its implementation can still be heavily influenced by these informal norm-based approaches. As a result, we predict that IPR regime strengthening will have less effect on Chinese firms' patenting strategy change (to adopt more utility model patents).

In contrast to Chinese firms, Western firms are considered to be more sensitive to the changes in formal IPR protection, because they traditionally attach greater importance to formal rules and regulations in their home countries (Branstetter et al., 2006; Grossman & Helpman,

1991). Their developed home institutional environments usually have clearly stipulated rules and effective enforcement, which reduce the need for them to rely on informal institutions to protect their intellectual assets from infringement. In addition, as they have developed their organizational routines to suit the developed institutional environment of their home countries, these routines can constrain them from effectively adapting to the complex and sometimes ambiguous institutional environment in China (e.g., Kostova & Zaheer, 1999). Indeed, when the host country has weak IPR protection, foreign firms tend to concentrate their R&D activities in areas where technology is less vulnerable to expropriation or where legal protection is relatively higher (Moser, 2005). Therefore, when there is a strengthening of IPR regime in the host country, we predict a greater increase in the adoption of patents with improved protection by Western firms than by Chinese firms. We hypothesize that:

Hypothesis 2. Upon the strengthening of a previously weak form of IPR protection (utility model patent), the increase in its adoption is smaller for Chinese firms than for Western firms.

Variation in the Quality of the IPR System across Regions

Although the improvement in IPR regime generally leads to better patent protection, the de facto quality of the IPR system across different regions of China may vary significantly. For example, in some of the Western provinces of China such as Guizhou, Qinghai, Shaanxi, and Yunnan, formal institutions for IPR protection and enforcement are not very effective (Fan, Gillan, & Yu, 2010). The IPR courts and legal systems in these regions are weak and often influenced by the local administrative agencies, which can present an obstacle to effective IPR protection. Thus, a higher risk of expropriation of their innovations exists for firms conducting R&D in these regions. By contrast, the de facto IPR quality is often (but not always) higher in the coastal provinces such as Guangdong, Zhejiang and Shandong, and in certain Chinese

municipalities such as Beijing, Shanghai and Tianjin.[2] These regions have more robust IPR institutions (Du, Lu, & Tao, 2008; World Bank, 2008). Furthermore, compared with those in the western provinces, the IP courts in the municipalities are more separated from and thus less influenced by local administrative agencies. Therefore, the ambiguity of interaction between institutions decreases and the IP courts are more responsive and effective in IPR litigation and enforcement to protect the intellectual property assets of foreign and domestic firms.

Given firms' various strategic considerations, the R&D activities of Chinese and Western firms are distributed across different regions in China. Throughout the stages of the R&D process, firms continuously file patents to protect their innovations, typically in the same location where firms conduct their R&D (Fan & Wang, 2004; Wang, Fan, & Zhu, 2007). Moreover, firms that conduct R&D in the same region not only share the same formal legal institutions but also a similar informal institutional environment such as common "codes" of communication, conventions and norms. Such tacit knowledge and understanding resulting from the confluence between formal and informal institutions are heavily imbued with meaning arising from the social and institutional contexts in which it is produced. They are difficult to transmit over long distances and hence spatially sticky (Gertler, 2003).

As such, although Chinese firms in general are deeply embedded in China's institutional environment, those conducting R&D in regions with higher de facto IPR quality may have evolved gradually and become more adapted to their immediate environments where formal IPR institutions are stronger and regulations are clearer and less uncertain. The R&D process and decisions of these Chinese firms are continually influenced by the better developed (formal)

[2] A separate robustness analysis comparing economic indicators such as GDP, GDP per capita and population of each of the 31 Chinese provincial regions to their level of de facto IPR quality shows a pairwise correlation of 0.635, 0.217 and 0.519 respectively ($p < .001$). This suggests that the level of regional economic development does not always correlate with and can vary substantively from regional de facto IPR quality (details available upon request).

institutions and clearer legal rules in these regions. These better developed institutions help to reduce Chinese firms' reliance on informal norm-based approaches (such as those discussed before) for protection of their R&D outputs. Thus, over time, Chinese firms operating in these regions may become more reliant on the quality of formal institutions and behave more like their Western counterparts. As a result, these Chinese firms are more likely to respond to a formal IPR regime shift and thus exhibit a smaller difference from their Western counterparts.

Hypothesis 3. Upon the strengthening of a previously weak form of IPR protection (utility model patent), the difference in its adoption by Chinese and Western firms is less salient for technologies developed in regions with higher de facto IPR quality.

Variation in Western Firms' Operational Age in China

As Western multinational firms entered the Chinese market at different periods in time, the difference in their operational experiences in China may influence how much they have understood and learned about China's informal institutions, norms and practices. Earlier entrants typically enjoy greater learning experiences, enabling them to better understand their Chinese counterparts, domestic markets, governments, and business community (Pan & Chi, 1999). While Chinese philosophical roots and traditions cannot be easily transplanted to Western firms, Western firms may be able to learn and potentially assimilate informal norms and practices which are shaped by these philosophical origins over time through constant exposure to informal institutions and practices by their Chinese counterparts. Earlier Western entrants also have more time to cultivate relationships and guanxi with their key stakeholders (Kogut & Zander, 1993).

Many foreign firms in China have undergone a substantial transition from "foreign investors" to "strategic insiders" (Luo, 2007). The shifting competitive and regulatory environment for the past three decades has made China's market immensely competitive, requiring foreign firms to

effectively integrate and embed into the domestic market. Moreover, over the years, China's overall regulatory framework has been heading toward a similar treatment of foreign and local firms and more regulatory power by regional governments. Among several strategic implications of this transition (Luo, 2007: 19), foreign firms find it critical to adapt to local convention and practices, as well as to enhance cooperation with the host country government and business community. This requires foreign firms to appreciate and deliberately improve adherence to China's social norms that are deeply rooted in Chinese Taoism and Confucianism (e.g., Strutton & Pelton, 1997). Localization to the domestic knowledge pool and the cultivation of inter-organizational relationship with the domestic business community are also important for international firms to develop innovative competence (Almeida & Phene, 2004).

However, such adaptation takes time, especially given that the change in China's market and regulatory environment was gradual but substantial. Thus, earlier foreign entrants have had more learning opportunities to understand informal institutions and their interaction with formal institutions (Kogut & Zander, 1993; Pan & Chi, 1999). They are more likely to have accumulated experiences on dealing with intellectual property issues and have understood the effectiveness of different informal alternatives. They could also have had more opportunities to build social networks with the local government and the business community, facilitating greater access to informal institutions. Therefore, we suggest that the longer a Western firm operates in China, the more likely it has adapted to its informal institutions, and the more it may behave like a domestic Chinese firm in resolving IPR-related conflicts.

Hypothesis 4. Upon the strengthening of a previously weak form of IPR protection (utility model patent), the difference in its adoption by Chinese and Western firms is less salient for Western firms with longer operational experience in China.

METHODS

Empirical Context and Approach

As China's economy continues to expand, its next phase of growth explicitly targets the enhancement of indigenous innovative capabilities in science and technology to fuel its economic advancement further and reduce dependence on foreign technologies (State Council of China, 2006). To achieve such strategic policy directive, China has undertaken substantial efforts in recent years to strengthen and standardize its IPR legal framework in accordance with the international standards and guidelines of the World Intellectual Property Organization (WIPO). Major IPR reform, such as the 2001 patent law amendment, provides stronger IPR protection for innovations developed by both foreign and domestic Chinese technology firms, such as Lenovo in computing, Huawei in telecommunications, and Haier in consumer goods, as they move up the value chain (Hu & Mathews, 2008; SIPO, 2010). Such major IPR regime shift in China, along with the differences between Chinese and Western firms' embeddedness in China's informal institutions, provides a suitable setting to test our theoretical predictions.

Our study focuses on comparing Chinese and Western firms' shifts in patenting strategies on technologies of international importance. Such technologies should be developed in China, and also be of strategic importance in the face of global competition. Moreover, they should provide a common platform for comparing the patenting behaviors of Western and Chinese firms in China. To do this, we hand collected and constructed a data set of the entire population of patents applied by and awarded to Chinese and/or Western firms for the same inventions in China and in the U.S. from year 1985 to 2008. We chose the U.S. because it is the largest and the most technologically sophisticated market in the world and is the leading choice in which to obtain a patent for firms with technologies of international interest and importance. This sample captures

all China-originated technologies whose patents have been applied in China and the U.S. (through SIPO and USPTO respectively) and subsequently granted in both countries.

Our final sample includes 1,070 patents granted both in China and in the U.S. to the same 430 unique Chinese and Western firms[3] which operate and conduct R&D in China. The SIPO patents were applied by these firms from 1985 to 2006 and granted from 1986 to 2007; the USPTO patent counterparts were applied from 1985 and 2007 and granted from 1987 and 2008. A SIPO patent can be precisely linked to its USPTO patent counterpart using the priority right information identified in the USPTO patent if it is a transnational patent covering the same invention filed both in China and the U.S. A priority right (or right of priority) is a time-limited right triggered by the first filing of an application for a patent (i.e., the origin of a technological invention). The priority right belongs to the applicant or to his/her successor in title and allows him/her to file a subsequent patent application in another country for the same invention. For this subsequent application, the applicant can then benefit from the date of filing of the first application for the examination of certain requirements by the appropriate patent offices.[4] When filing the subsequent application, the applicant must legally "claim the priority" of the first application to make use of the priority right. Thus, priority right information in a patent can be used to link a China patent to its U.S. counterpart precisely and effectively. The period during which the priority right exists for patents is usually 12 months. The timeline in Figure 1 illustrates the relationship between a typical China patent and its U.S. counterpart.

[3] Firms from Hong Kong and Macau are excluded from the Chinese firm category. Including the patents filed by companies from these regions in the robustness analyses yielded consistent results. Western firms include those from the U.S., Germany, Switzerland, the U.K., France, Canada, Sweden, Italy, Netherlands, Finland, Denmark, Luxembourg, Liechtenstein, Spain, and Norway.

[4] Note that the examination and final granting of a patent in each country is independent of the others. Although a firm can choose (or not) to go through the Patent Cooperation Treaty (PCT), which provides a unified procedure for the possibility of filing an international application (i.e., a PCT application) in each of its contracting countries, it does not provide for a "multinational (or international) patent" (which does not exist). The reason is that the grant of patent is usually a prerogative of each national or regional authority (with few exceptions) and subject to the stringent patent examination and review procedure administered by individual countries.

Insert Figure 1 about here

This research design and data set yield the following advantages. First, they allow us to screen out inventions of lower quality (e.g., "junk" patents) by focusing on inventions that pass the patentability bar of novelty, usefulness and non-obviousness in both SIPO and USPTO.[5] These inventions developed in China are also important enough to the firms to be patented in the U.S., the largest and most technologically sophisticated market in the world. Consistent with previous studies (Jaffe, Trajtenberg, & Henderson, 1993; Murray & Stern, 2007), we account for the quality of these inventions by controlling for the cumulative forward citations to the matched USPTO patent, as citations to SIPO patents are not mandatory and therefore largely absent.

Second, as the USPTO awards only invention patents, whereas the SIPO awards both invention and utility model patents, and each SIPO patent in our data set is precisely linked to a USPTO patent covering the same invention, we observe a natural variation in terms of the firms' patenting choices in China. Unlike those in the U.S., firms in China can strategically choose to file for either of the two types of patents, even when the technology is of sufficient merit and importance to the firm for it to be filed in the U.S. and granted a USPTO invention patent. This natural variation, together with other controls for "quality" or "value" of inventions such as citation counts, helps to mitigate the concern that a utility model patent is simply filed because the associated technology is inferior. Our focus at the patent level enables a more nuanced observation of and control for the characteristics of each patented technology in terms of its strength, scope and quality. At the same time, this set-up allows us to control for firm characteristics at the aggregated firm level. Moreover, the larger number of observations at the

[5] For example, the USPTO patent approval rate has dropped from about 72 percent in 2000 to 44 percent in 2008 (Wild, 2008). SIPO has a similar average approval rate of about 44 percent from 1985 to 2007 (SIPO, 2008b).

patent level also provides greater statistical power to our empirical tests.

Third, we exploit the 2001 patent law reform, which is a major regulatory change in China as an exogenous shock. This is a top-down reform designed and implemented by the central government. It was announced and adopted on August 25, 2000 and became effective on July 1, 2001. Table 1 provides a summary of the 2001 China patent law amendment. This natural experiment allows us to isolate the impact of strengthening and clarifying formal IPR regime especially for the previously weak form of IPR protection (i.e., utility model patents) on Chinese and Western firms' strategic patenting choices.

Insert Table 1 about here

Measures

Dependent variable. Our dependent variable is captured by a dummy variable that indicates whether a patent is filed as a utility model patent. It is set to 1 if the firm applies for the utility model patent for a particular technology (and 0 if the firm applies for an invention patent). This is our variable of interest as with the increase in firms' adoption of utility model patents (relative to the invention patent), there is a greater likelihood that the variable is 1.

Independent variables. Our key explanatory variable is IPR change in force. It is a dummy variable equal to 1 for all years since the implementation of the major China IPR law change in 2001, and 0 for years prior to the change. Chinese firm denotes if the firm awarded the patent originates from or is home based in China. Western firm denotes if the firm awarded the patent originates from or is home based in a Western country. We use either the Chinese firm or the Western firm dummy in different models, based on what is required to best test the corresponding hypotheses. For example, we use the interaction term between IPR change in

force and Chinese firm to test the differential impact of IPR law change on Chinese the Western firms, as suggested by Hypothesis 2.

De facto IPR quality is captured by the average number of patent infringement and dispute cases processed and enforced annually in local authorities for patent affairs in each of the 31 provinces and municipalities in China (e.g., Fan et al., 2010). Following previous studies (Zhao, 2006), a patented technology is considered developed in a particular region when 50% or more of the inventors in the patent are based in the region. As discussed before, regions with high de facto IPR quality are sometimes (but not always) coastal provinces or major municipalities in China with traditionally greater presence of Western firms and their R&D facilities. We interact de facto IPR quality with IPR change in force and Chinese firm to test the effect of variation in IPR quality across different regions in China, as suggested by Hypothesis 3.

Operational age in China is defined as the number of years the firm assigned to a particular technology patent has had formal operational facilities in China until the year of observation (i.e., patent application year). We use the natural log of the number of years plus one in our analyses to capture the non-linear effect associated with operational age as the marginal learning effect may decrease as experience grows (e.g., Argote & Epple, 1990). The interaction term between Operational age in China, IPR change in force and Western firm is used to test the effect of variation in Western firms' experience in China, as suggested by Hypothesis 4.

Control variables. We include the following patent-level controls. Window year 2000 is a dummy that is coded 1 in the year 2000 when the IPR law change was announced (on August 25). This variable helps us to account for the noise associated with that particular year of announcement. Number of claims denotes the number of legal claims made by a U.S. patent which provides a proxy for patent strength (Harhoff & Reitzig, 2004; Lanjouw & Schankerman,

2001). Number of classes denotes the number of patent technology classes in the U.S. patent that provides a proxy for patent scope (Lerner, 1994; Scotchmer, 1991). Cumulative citations captures the total number of forward citations received by a particular patent until 2008. This variable provides an additional control for the quality and importance of the patented technology (Furman & Stern, 2011; Jaffe, Trajtenberg, & Henderson, 1993).

We also include the following firm-level controls. Private firm is a dummy that is coded 1 when the firm is not publicly listed, that is, has not gone through initial public offering (IPO), and coded 0 when the firm is publicly listed. Years since founding is defined as the number of years the firm assigned to a particular patented technology has been founded, whether in China or in a Western country, until the year of observation (i.e., patent application year). Similarly, we use the natural log of the number of years plus one in our analyses to capture the non-linear effect learning associated with this variable. Performance of private firms differs from that of public ones under resource constraints (George, 2005). Firms that are private or young could also be more entrepreneurial (Agarwal, Ganco, & Ziedonis, 2009). Therefore, they may exhibit different, perhaps more aggressive, innovation and patenting strategies compared with older and more established public firms. Following prior studies (e.g., Jaffe, Trajtenberg, & Henderson, 1993; Murray & Stern, 2007), we also include lifetime patents, which is the total number of patents awarded by the USPTO until 2008 to each firm, to control for the level of innovative capability of the firm especially for technologies of international importance.

Finally, we include a set of technology sector controls. Based on a large body of literature (Cohen, Nelson, & Walsh, 2000; Hall & Ziedonis, 2001; Huang, 2010; Levin et al., 1987), is the set consists of six dummy variables each denoting whether a patent belongs to a particular discrete technology sector (i.e., pharmaceutical or chemical) or to a particular complex

technology sector (i.e., computing, semiconductor, information technology, or communications). Firms can adopt different patenting strategies for technologies in different sectors. Each patent in the discrete technology sectors has a higher substantive value for product development and protection against expropriation (von Graevenitz, Wagner, & Harhoff, 2011). Patents in complex technology sectors usually have higher strategic value as cross-licensing bargaining chips, and for establishing IPR territories (Hall & Ziedonis, 2001). Table 2 shows the descriptive statistics and pairwise correlations of the variables described above.

Insert Table 2 about here

We utilize the following major data sources to construct the above measures. (1) Data on the U.S. patents, citations, and patent characteristics are derived from the USPTO. (2) Data on the China patents, citations, and patent characteristics are obtained from the SIPO. (3) Data on the IPR quality of each of the 31 Chinese provinces and municipalities are based on the IPR dispute, enforcement and resolution statistics obtained from the SIPO Annual Reports. Although this information is only available from year 2000, it is reasonably stable and consistent over time across each provincial region in China. (4) Data on firms' operational age in China and years since founding are manually collected based on the official firm websites and firms' annual reports. (5) Data on whether the firm is publicly listed are obtained from Compustat Global Data, supplemented by the information from official firm websites and annual reports.

Model Estimation

We employ logistic regression models because our dependant variable is dichotomous. We also consider two methodological issues. First, to better examine the effect of the IPR regime shift after 2000 on firms' patenting choices, we restrict our analyses in the most stringent models

(described in the Results section) to the subsample of patents applied up to five years before (1995 to 1999) and five years after the patent law reform announcement (2001 to 2005). Furthermore, we restrict firms in our sample to those that have operated in China for at least three year before the announcement (since 1997) to ensure that we have meaningful statistics on the firm's patenting behavior prior to 2000.

Second, as many patent observations in our sample have been applied by and awarded to the same firm, these observations might be influenced by the same unobserved fixed firm characteristics that vary over time. This may violate the independence between these observations and bias estimation. Hence, we need to account for such within-firm interdependence and firm heterogeneity. This is typically done by including a set of firm dummies to control for firm fixed effects. However, as the key independent variable Chinese firm is a dummy variable, applying firm fixed effects will generate perfect collinearity between variables and make the interpretation of estimated coefficients very difficult. Therefore, we choose to use logistic regression models with robust standard errors adjusted by clustering over firms to account for potential correlation in the error terms and control for any unobserved heterogeneity across firms in our sample. Moreover, this approach is favored over a fixed-effects logistic estimation because it allows us to preserve observations from companies that did not switch between utility model patents and invention patents upon the IPR regime shift. Non-varying outcomes within firms (i.e., no switch) contain valuable information about the firm's patenting strategies and thus should be incorporated.

RESULTS

Models 3-1 to 3-4 in Table 3 present the results of the testing of Hypothesis 1. Model 3-1 is the baseline specification with the patent-level, firm-level and technology sector controls for all

observations between 1985 and 2008. Model 3-2 includes *IPR change in force* but excludes any interaction terms. When IPR regime strengthens after 2000 (IPR change in force = 1), the odds of obtaining a utility model patent significantly increase by a factor of 7.20 (equal to exp(1.974), $p < .001$) on average for both Chinese firms and Western firms. In model 3-3, we restrict the analyses to the subsample of China patents applied from 1995 to 2005 and to firms that have operated in China since 1997. In the most stringent full model 3-4, we apply the same restrictions and clustered standard errors by firms to control for the underlying unobserved heterogeneity across the firms in our sample. Both models show that the odds of obtaining utility model patent by firms significantly increase by a factor of 7.84 (equal to exp(2.059), $p < .001$) after the major IPR law reform. This suggests that the strengthening of the utility model patent protection has effectively increased firms' incentives to apply for it. Thus, Hypothesis 1 is supported.

Insert Table 3 about here

Models 3-5 to 3-7 test the differential response of Chinese versus Western firms in the odds of utility model patenting after the IPR improvement. Model 3-5 includes the interaction between IPR change in force and Chinese firm. It suggests that IPR regime strengthening increases the odds of choosing the utility model patent by a factor of 12.54 (equal to exp(2.529), $p < .001$) for Western firms and by a factor of 5.59 (equal to exp(2.529-0.808)) for Chinese firms (although the interaction term in this model is not significant). Model 3-6 shows the results for the more stringent subsample as in model 3-3. We find stronger positive effects of IPR change in force by a factor of 61.87 ($p < .001$) for Western firms and by a factor of 5.78 ($p < .05$) for Chinese firms. Model 3-7 shows the most stringent full model with the same restrictions and clustered standard errors by firms to control for the underlying unobserved heterogeneity across the firms in our sample. The results are largely similar to those of model 3-6. The marginal probability of

Chinese firms adopting utility model patenting after the strengthening of IPR law is 0.51 ($p < .001$) compared with the probability of 0.23 ($p < .01$) before the law change. Conversely, there is a much higher marginal probability of 0.74 ($p < .001$) for Western firms to adopt utility model patenting after the IPR law strengthening, compared with the probability of 0.14 (non-significant) before the law change. Taken together, these results provide support for Hypothesis 2.

It would be important to explore whether the effects of the patent law strengthening might have started even before the announcement of the law change and whether such effect takes time to manifest itself after the change. To do this, we estimate a logistic regression model with controls similar to those in model 3-7 but including dummy variables for each of the three years preceding and following the law change, when the effects might have been most salient. Figure 2 shows the coefficients, reported as odds ratios, from that specification. Whereas a decline for Western firms is observed in the year before the law change, a sharp and continued increase is observed over the three years after the change. There seems to be little or no effect on Chinese firms before the change, and only a slight overall increase over the three years after the change.

Insert Figure 2 about here

Models 4-1 and 4-2 in Table 4 report the results of the testing of Hypotheses 3 by estimating the effects of de facto institutional environments in IPR quality across different regions in China. In model 4-1, we apply similar restrictions in our logistic regression like in models 3-3 and 3-6. We include all two-way interactions and three-way interactions between Chinese firms, IPR change in force, and de facto IPR quality. The significant and negative coefficient ($p < .001$) of IPR change in force X Chinese firm suggests as above a smaller increase for Chinese firms in utilities model patenting. However, the significant and positive coefficient ($p < .01$) of the three-way interaction, IPR change in force X Chinese firm X de facto IPR quality, indicates such

difference between Chinese and Western firms will decrease if the quality of regional IPR system increases. For instance, in regions with de facto IPR quality measured at one standard deviation below the mean (19), the IPR shift causes Chinese firms to increase the odds of utility models patenting by only 0.03% (equal to exp(-8.993+19*0.043)) of the odds increase in Western firms, whereas in regions with a mean IPR quality (126), the figure increases to 3%. Model 4-2 with restrictions and clustered standard errors by firms (similar to those in models 3-4 and 3-7) yields similar and significant results (although the significance is reduced to $p < .05$ for the three-way interaction term). Taken together, these results suggest that the difference between Chinese and Western firms' strategic patenting behavior becomes less salient when they develop their technologies in regions of higher de facto IPR quality. Thus, Hypothesis 3 is supported.

Insert Table 4 about here

Models 4-3 and 4-4 show the moderating effects of firms' operational age in China (Hypothesis 4). As our theoretical focus here is on the variation in patenting strategy change among Western firms (relative to Chinese firm) as their operational age in China increases, we use Chinese firm as the basis for comparison in these regression models. In model 4-3, we apply similar restrictions to those in model 3-3 and 3-6. The non-significant coefficient of IPR change in force in model 4-3 suggests that Chinese firms (when Western firm = 0) show no apparent change in the odds of utility model patent after the IPR shift. The significant and positive coefficient of IPR change in force X Western firm (13.087, $p < .001$) suggests that relative to Chinese firms, Western firms substantially increase the odds after the IPR shift. However, the significant and negative coefficient of the three-way interaction (-3.401, $p < .001$), IPR change in force X Western firm X operational age in China, suggests that such odds difference will decrease as the operational age of Western firms increases. For instance, at the mean operational

age in China (1.88, or about 7 years), the odds increase for Western firms after the IPR shift is 807 times (equal to exp(13.087-3.401*1.88) that for Chinese firms. However, at one standard deviation above the mean (3.27, or 26 years) of operational age in China, the number is reduced to 7 times. This finding is consistent with our argument that Western firms behave more like their Chinese counterparts as they become more embedded in China's informal institutional environment. The results in the most stringent model 4-4 are similar to those in model 4-3 and remain as significant ($p < .001$ in the case of the coefficient for the three-way interaction term) after incorporating restrictions and clustered standard errors by firms (similar to those in models 3-4 and 3-7). In sum, these results suggest that the difference between Chinese and Western firms in their changes in patenting strategy post IPR regime shift is less salient for Western firms with longer operational experience in China. Therefore, Hypothesis 4 is supported.

Supplementary Analyses

We investigated the robustness of our results in several additional ways (detailed results are available from the authors). First, we assessed whether our findings are sensitive to different window periods, IPR regime change in force periods, patent application year and age restrictions. To do this, we analyzed alternative window periods (e.g., 1999 or 2001) and IPR regime change in force periods (e.g., after 2001 or after 2002) using regression models similar to those in Tables 3 and 4. The results are consistent with the main models reported. Similarly, we applied alternative restriction criteria: different ranges of patent application years with reference to the law reform announcement in 2000 ($\pm$3 years and $\pm$7 years), and a different operational age requirement (up to 5 years before the announcement) in the more stringent models 3-3 to 3-4, 3-6 to 3-7 and 4-1 to 4-4. Again, the results are largely similar and consistent.

Second, we checked if the implementation of an earlier Chinese patent law amendment in 1992 affects our results. The 1992 amendment was the first major reform of the Chinese patent law system and hence provided some preliminary changes to increase the enforcement of patent holders' rights and the scope of patent protection. Since these preliminary changes occurred in the early years of China's patent system and there are few changes specific to the utility model patent, it is of less theoretical and empirical interest to us for the purpose of this study. Nevertheless, controlling for it using a dummy variable which denotes a 1 for the years from 1993 to 2000 (and 0 otherwise) in the more stringent models 3-3 to 3-4, 3-6 to 3-7 and 4-1 to 4-4 yielded similar and consistent results.

Third, we examined whether alternative measures of the quality and value of patented technologies could affect our results and interpretations. In particular, we substituted cumulative citations in the main models with cumulative citation without firm self-citation which provides an alternative control for the quality and importance of the patented technology to non-focal firms. The results are similar and consistent. We also checked whether applying an alternative measure of de facto IPR quality, that is, the efficiency of regional IPR system in China, could affect our results. To do this, we constructed the ratio of patent infringement and dispute cases to those cases resolved in the administrative authorities for patent affairs such as IPR courts. Substituting de facto IPR quality with this efficiency ratio in models 4-1 and 4-2 yielded largely similar and consistent results.

Fourth, we conducted analyses to understand further the extent to which the smaller increase in utility model patent adoption by Chinese firms post IPR regime shift is more influenced by their philosophical traditions or their familiarity with the local environment (e.g., Zaheer, 1995). To do this, we first excluded (domestic) Chinese firms from our sample. Then, we added (foreign)

Taiwanese firms in our sample to compare them with (foreign) Western firms using regression analysis similar to that in model 3-7 but replacing the variable Chinese firm and its interaction term with Taiwanese firm and its corresponding interaction term. As illustrated in Table 5, similar to Chinese firms, Taiwanese firms are deeply influenced by traditional Chinese philosophies that shape their informal institutional norms and approaches. However, like Western firms, Taiwanese firms are not as familiar with the local operating environment as their Chinese counterparts. Although both Taiwanese and Western firms increase their adoption of utility model patents, there is a significantly lesser increase in adoption by Taiwanese firms after the IPR reform than by Western firms. Comparing Chinese and Taiwanese firms, we find no significant difference in their adoption of utility model patents after the IPR reform. Taken together, these findings suggest that the effects found are better attributed to the philosophical–cultural difference between Chinese and Western firms than simply to Chinese firms' greater familiarity with the local operating environment.

Insert Table 5 about here

Furthermore, to verify that philosophical–cultural differences do play an important role in influencing the differential responses between Chinese and Western firms to IPR regime shift, we coded Hofstede's (2001) measure of long-term orientation (LTO), also known as the "Confucian dynamism", based on the firms' country of origin. While traditional philosophies are closely associated with but are not completely in accordance with a society's broader culture, this measure provides preliminary evidence on the role of philosophical–cultural differences. Moreover, despite the limitations of Hofstede culture measures (Shenkar, 2001), they have been extensively used in studies on international business (e.g., Tihanyi, Griffith, & Russell, 2005)

and innovation and entrepreneurship (e.g., Shane, 1995; Steensma, Marino, & Weaver, 2000). Particularly, the LTO dimension is closely related to the teachings of Confucius and can be interpreted as dealing with society's search for virtue – the extent to which a society shows a pragmatic long-term oriented perspective or approach that is less confrontational (with higher LTO value) than a conventional short-term point of view (with lower LTO value). Although this dimension is not a perfect representation of the philosophical–cultural influence of Confucianism on firms, it can shed light on the effect of the interaction of informal institution with formal IPR regime change on firms' patenting behavior. To conduct this analysis, we expanded our data set to include the same patents awarded by both SIPO and USPTO to Chinese, Western as well as other Asian firms in China. Asian firms include those from Taiwan, Japan, Hong Kong, South Korea, Singapore, and India. Following the above procedure, we obtained 1,810 patents granted in both China and the U.S. to 702 Chinese, Asian and Western firms. We defined and coded the continuous variable LTO distance from China as the difference in the absolute value of LTO of a country from that of China, which has the highest LTO value of 118 among all countries based on the Hofstede (2001) measure. Compared with firms from Asian countries, firms from the U.S. and other Western countries have greater LTO distance from China, which corresponds to their low values in the LTO dimension. Given that cultural values are relatively stable over time (Hofstede, 2001), we treated this measure as time-invariant in our analysis. We then employed a regression model similar to Model 3-7 but substituted Chinese firm with LTO distance from China; and substituted the interaction between IPR change in force and Chinese firm with the interaction between IPR change in force and LTO distance from China. The effect of the patent regime improvement on utility model patent adoption significantly increases with LTO distance from China (0.044, $p < .05$). This finding again suggests that the underlying philosophical–

cultural influence of Confucianism plays an important role in explaining the differential strategic patenting responses among firms after the improvement of a formal IPR regime.

DISCUSSION AND CONCLUSION

The formal intellectual property rights regime provides the rule of law and incentive system to encourage innovation. Policymakers in transitional economies such as China have taken major steps toward standardizing and clarifying such regime in the hope of fostering innovative activities. Thus, with the strengthening of IPR protection after China's patent law reform of 2001, firms operating in China are expected to increase their adoption of the improved form of IPR – utility model patents – to safeguard their internationally valuable innovations. Our empirical analyses confirm this argument. More intriguingly, we find that a significant difference exists between Chinese and Western firms in China in terms of their response to the patent law reform. Chinese firms in general do not increase their adoption of such internationally valuable patents as much as their Western counterparts do (the difference is large, at up to 56 times empirically).

In the current study, we attempt to address this question from the institutional theory perspective. We argue that informal institutional norms and practices deeply rooted in the traditional Chinese philosophies of Taoism and Confucianism can manifest in Chinese firms' approach to safeguarding their intellectual property assets. This could result in their resorting less to more confrontational formal legal litigations against potential expropriation of their innovations. Moreover, we further find that the difference in the adoption of utility model patents upon the strengthened IPR protection between Chinese and Western firms is negatively moderated by the level of de facto institutional quality of the IPR system in the region where the companies conducts their R&D. This finding suggests that although Chinese firms are embedded in informal institutions shaped by traditional Chinese philosophies, they can also be influenced

by local institutional quality and can take advantage of clearer local institutional rules and reduce their reliance on informal mechanisms over time. Consequently, their strategic response to a formal IPR regime shift becomes more like that of their Western counterparts in those regions.

Moreover, we find that such difference in the adoption between Western and Chinese firms is negatively moderated by the increasing operational age of Western firms in China. This finding suggests that although informal norms and practices are formed over a long period of time and rooted in Chinese traditional philosophies, they are not completely inaccessible to outsiders. Over time and with constant exposure to the norms and practices of their Chinese counterparts, Western firms can better understand and adapt to China's informal institutions through experiential learning. As their operational age in China increases, their patenting strategies and responses to a formal IPR regime shift can become more like those of their Chinese counterparts.

This study makes several contributions. First, through a new conceptual lens, we examine how and why Chinese and Western firms employ differential innovation strategies in response to major formal IPR regime changes. Therefore, this study contributes to the sparse but growing literature that has begun to explore the interaction between formal and informal institutions in influencing entrepreneurial activities and investment choices in less developed countries (e.g., Batjargal et al., 2012; Hitt et al., 2004; Holmes et al., 2011; Tonoyan et al., 2010). Furthermore, by conceptualizing how informal institutional norms and practices adopted by Chinese firms can be shaped by deep-rooted Chinese philosophies and the influence of complex and interdependent institutional forces, we theoretically identify the general tendency of Chinese firms for conflict avoidance and reliance on bureaucratic approaches for conflict resolution pertaining to the protection of their intellectual assets.

Although previous studies discussed the substitutive effects between formal and informal institutions (e.g., Batjargal et al., 2012; Xin & Pearce, 1996), there has been little or no systematic examination of how such substitutive effect occurs and how it may impact firms' adaptation to formal institutional changes, as we have done in the current study. In particular, we have outlined specifically how informal practices and norms function in China's IPR context. In addition, our arguments imply that the strengthening of formal institutions does not necessarily weaken the role of informal institutions, especially when there is a complex and ambiguous interdependence between institutions, as the implementation of formal legal rules has been and is likely to continue to be intervened by informal practices and norms.

This study also makes several methodological contributions. By focusing on patents applied and granted to the same invention by the same firm across both China and the U.S., we can better take into account of the quality and value of such inventions developed in China. Given that the large perceived difference in technology capability and patent quality of Chinese from those of Western firms, such an empirical approach provides a common platform for comparing the patenting strategies of Chinese and Western firms in China. Another key methodological contribution of this study lies in its natural experiment setting, which effectively mitigates the concern for reverse causality and endogeneity. This study contrasts with the prior research studies in this area, which mostly focused on variation in institutional environment and firm strategies across countries (e.g., Batjargal et al., 2012; Hitt et al., 2004). Our unique research setting and design enable us to examine how firms respond differently to the same exogenous shock in formal institutions within one country.

Policy and Strategy Implications

Our findings have policy implications for the governments of China and other economies sharing similar philosophical and cultural roots. Policymakers can encourage innovative and patenting activities by designing and implementing more effective formal laws to reinforce the current IPR regime. Moreover, when formulating policy to stimulate innovation, they should consider the informal institutional norms and practices by domestic and foreign firms, and the quality of local IPR systems, which all have substantial and real influence on the effectiveness of formal regime reforms. By shedding light on the potential underlying micro-level mechanisms that may lead to different responses by Chinese and foreign firms to formal IPR regime shift, this study has important implications for macro-level innovation output and helps policymakers better assess the effectiveness of IPR policies.

Our findings also have managerial implications for both Chinese and Western firms operating in China. For Chinese firms, while a heavy reliance on China's informal institutions for IPR conflict resolution may be effective in the Chinese market, it may prevent them from accumulating experiences and developing capabilities in dealing with formal institutions. These experiences and capabilities are necessary for Chinese firms to compete effectively in the global market. On the other hand, obtaining a better understanding of and becoming more acquainted with China's informal norms and practices are important for Western firms. Doing so may yield substantial long-term benefits such as having better knowledge of the innovation strategies of their Chinese competitors and adopting alternative non-legal and potentially less costly strategies to resolve IPR-related disputes and infringements, which are commonplace in transitional economies such as China.

REFERENCES AVAILABLE UPON REQUEST

TABLE 1
Summary of the 2001 China Patent Law Amendment

2001 China Patent Law Amendment
Adopted and announced at the 17th Session of the Standing Committee of the 9th National People's Congress on 25 August 2000 and effective on 1 July 2001. Top-down reform.

Objective:	To promote the development and innovation of science and technology
Motivation:	Membership into World Trade Organization (WTO)
	Patent law fully in line with TRIPS agreement
	Enhances innovations from Chinese/domestic technology firms
Changes implemented:	
Examination/ Review	More efficient examination and approval procedures
	Patentability of a utility model patent subject to judicial review
	Search report for utility model that can be obtained after substantive examination may be required
Patent scope	Right to patent goes to employer if employee uses materials and resources of the employer to make invention
Assignee right	Exclusive right of "offering for sale" extended to assignee
	More severe punishment for violation of existing patent right
	Stricter licensing procedures
	Use or sale of patented product without knowing that it was patented now considered infringement

Source: SIPO (2000): Patent law of the People's Republic of China

TABLE 2
Descriptive Statistics and Correlation Matrix[a]

	Variable	Mean	s.d.	1		2		3		4		5	
1	Utility model patenting	0.38	0.49										
2	Window year 2000	0.11	0.31	-0.10	***								
3	IPR change in force	0.57	0.50	0.39	***	-0.41	***						
4	Number of claims	14.36	9.67	-0.05	+	0.03		-0.01					
5	Number of classes	4.32	3.24	-0.17	***	0.03		-0.17	***	0.10	**		
6	Cumulative citations	2.40	8.03	-0.11	***	-0.04		-0.25	***	0.17	***	0.04	
7	Private firm	0.86	0.34	0.27	***	0.01		0.32	***	-0.02		-0.16	***
8	Years since founding	2.59	1.44	0.12	***	-0.06	+	0.16	***	-0.06	+	-0.14	***
9	Lifetime patents	2620	10636	-0.16	***	0.03		-0.15	***	0.03		0.07	*
10	Chinese firm	0.74	0.44	0.11	***	-0.01		0.28	***	-0.17	***	-0.03	
11	Western firm	0.44	0.50	0.24	***	-0.11	***	0.04		0.23	***	-0.03	
12	De facto IPR quality	125.82	106.59	0.41	***	-0.04		0.30	***	0.00		-0.14	***
13	Operational age in China	1.88	1.39	0.10	**	-0.03		0.36	***	-0.13	***	-0.09	**

	Variable	6		7		8		9		10		11		12
7	Private firm	-0.18	***											
8	Years since founding	0.03		0.19	***									
9	Lifetime patents	0.08	*	-0.45	***	0.35	***							
10	Chinese firm	-0.19	***	0.12	***	-0.34	***	-0.38	***					
11	Western firm	0.09	**	0.03		0.48	***	0.27	***	-0.66	***			
12	De facto IPR quality	-0.16	***	0.28	***	0.34	***	-0.04		0.15	***	0.30	***	
13	Operational age in China	-0.14	***	0.23	***	0.67	***	0.11	***	0.35	***	-0.04		0.34 ***

[a] n = 1,070 *** p < .001, ** p < .01, * p < .05, + p < .1

TABLE 3
Logistic Regression Models on the Effects of IPR Law Reform

	3-1	3-2	3-3	3-4	3-5	3-6	3-7
Variables	Model with controls only	Model without interaction	Main model without interaction but with restrictions	Full model without interaction but with restrictions clustered by firms	Model with interaction	Main model with interaction and restrictions	Full model with interaction and restrictions clustered by firms
Window year 2000		0.727+	1.325*	1.325+	0.626+	1.263*	1.263+
		[0.376]	[0.589]	[0.706]	[0.377]	[0.571]	[0.667]
IPR change in force		1.974***	2.059***	2.059***	2.529***	4.125***	4.125**
		[0.287]	[0.495]	[0.623]	[0.455]	[1.047]	[1.296]
Number of claims	0.004	-0.006	0.006	0.006	-0.006	0.015	0.015
	[0.010]	[0.011]	[0.019]	[0.038]	[0.011]	[0.020]	[0.037]
Number of classes	-0.050	-0.038	-0.042	-0.042	-0.037	-0.040	-0.040
	[0.032]	[0.031]	[0.056]	[0.055]	[0.031]	[0.057]	[0.055]
Cumulative citations	-0.114***	-0.031	-0.067	-0.067	-0.032	-0.056	-0.056
	[0.033]	[0.026]	[0.075]	[0.091]	[0.028]	[0.078]	[0.094]
Private firm	2.015***	1.421**	1.083	1.083+	1.474**	0.966	0.966
	[0.462]	[0.465]	[1.012]	[0.647]	[0.472]	[0.988]	[0.721]
Years since founding	0.182*	0.057	-0.417*	-0.417	0.071	-0.451**	-0.451
	[0.078]	[0.081]	[0.174]	[0.472]	[0.081]	[0.173]	[0.468]
Lifetime patents	-0.000*	-0.000*	-0.000+	-0.000	-0.000*	-0.000	-0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Chinese firm	0.136	-0.367	-0.845*	-0.845	0.088	0.819	0.819
	[0.238]	[0.249]	[0.403]	[0.851]	[0.401]	[1.005]	[1.095]
IPR change in force					-0.808	-2.370*	-2.370+
X Chinese firm					[0.510]	[1.094]	[1.398]
Constant	-1.990***	-2.174***	-0.049	-0.049	-2.508***	-1.375	-1.375
	[0.540]	[0.570]	[1.202]	[2.204]	[0.609]	[1.283]	[2.007]
Technology sector controls	YES	YES	YES	YES	YES	YES	YES
Observations	1,070	1,070	449	449	1,070	449	449
Psudo R-square	0.235	0.292	0.308	0.308	0.295	0.318	0.318
Log-likelihood	-429.608	-397.644	-214.300	-214.300	-396.286	-211.428	-211.428
Wald Chi-Sq	143.321	202.506	130.378	660.796	208.543	119.019	1408.997

Robust standard errors in brackets. *** p < .001, ** p < .01, * p < .05, + p < .1

TABLE 4 Logistic Regression Models on the Effects of De Facto IPR Quality and Operational Age

	4-1	4-2	4-3	4-4
Variables	De facto regional IPR quality	De facto regional IPR quality clustered by firms	Operational age in China	Operational age in China clustered by firms
Window year 2000	1.674*	1.674*	1.590*	1.590*
	[0.695]	[0.783]	[0.629]	[0.686]
IPR change in force	9.508***	9.508***	1.132	1.132
	[1.960]	[2.675]	[1.401]	[1.455]
Number of claims	0.004	0.004	-0.025	-0.025
	[0.024]	[0.035]	[0.020]	[0.023]
Number of classes	-0.034	-0.034	-0.047	-0.047
	[0.072]	[0.072]	[0.061]	[0.056]
Cumulative citations	0.007	0.007	0.037	0.037
	[0.074]	[0.080]	[0.058]	[0.062]
Private firm	-0.026	-0.026	0.692	0.692
	[0.867]	[0.633]	[1.287]	[1.040]
Years since founding	-0.504**	-0.504	-0.330	-0.330
	[0.187]	[0.426]	[0.722]	[0.764]
Lifetime patents	-0.000	-0.000	-0.000	-0.000
	[0.000]	[0.000]	[0.000]	[0.000]
Chinese firm	4.417**	4.417*		
	[1.660]	[2.140]		
De facto IPR quality	0.025+	0.025+		
	[0.013]	[0.015]		
IPR change in force	-8.993***	-8.993***		
X Chinese firm	[1.933]	[2.658]		
IPR change in force	-0.033*	-0.033*		
X De facto IPR quality	[0.014]	[0.017]		
Chinese firm	-0.027*	-0.027+		
X De facto IPR quality	[0.013]	[0.016]		
IPR change in force X Chinese	0.043**	0.043*		
firm X De facto IPR quality	[0.014]	[0.017]		
Western firm			-3.811*	-3.811+
			[1.922]	[2.309]
Operational age in China			-0.590	-0.590
			[0.732]	[0.785]
IPR change in force			13.087***	13.087***
X Western firm			[3.021]	[3.414]
IPR change in force			0.138	0.138
X Operational age in China			[0.514]	[0.506]
Western firm			1.243*	1.243+
X Operational age in China			[0.594]	[0.707]
IPR change in force X Western			-3.401***	-3.401***
firm X Operational age in China			[0.934]	[0.975]
Constant	-3.760*	-3.760	0.896	0.896
	[1.761]	[2.521]	[1.588]	[1.535]
Technology sector controls	YES	YES	YES	YES
Observations	389	389	449	449
Psudo R-square	0.326	0.326	0.460	0.460
Log-likelihood	-181.730	-181.730	-167.292	-167.292
Wald Chi-Sq	132.678	2345.592	128.980	2181.430

Robust standard errors in brackets. *** p < .001, ** p < .01, * p < .05, + p < .1

TABLE 5
Matrix for Supplementary Analysis on the Effects of Familiarity with Local Environment and Influence by Confucianism and Taoism

	Local	Foreign
Strong Influence by Confucianism and Taoism	Chinese firms	Taiwanese firms
Little or no influence by Confucianism and Taoism		Western firms

FIGURE 1
Relationship of a Typical China Patent and its U.S. Patent Counterpart and Follow-on U.S. Patent Citations

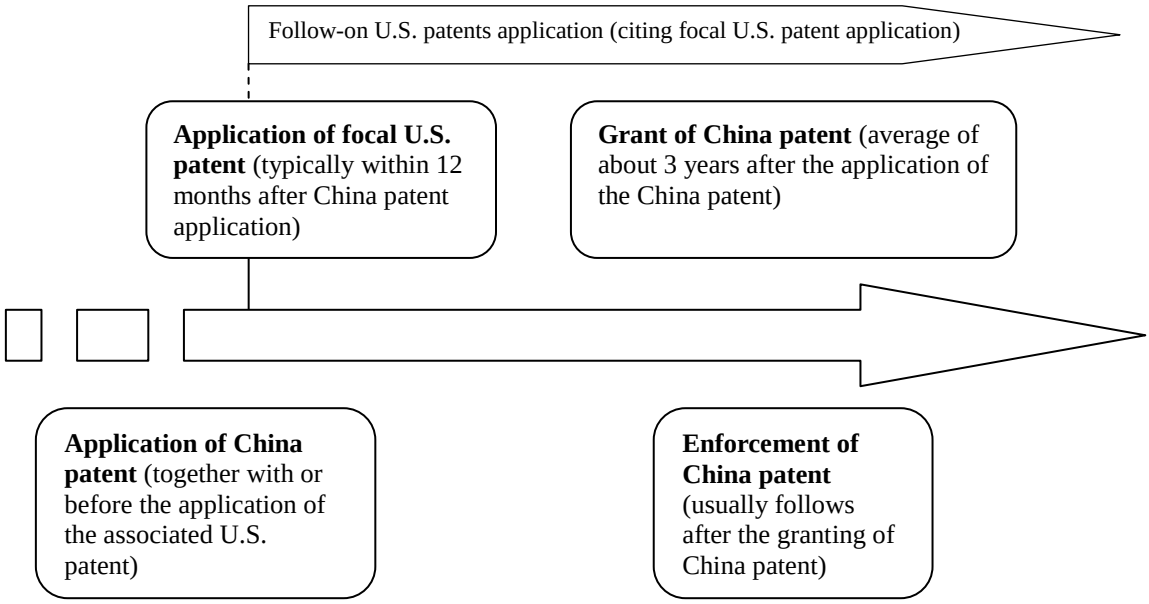

FIGURE 2
Impact of Patent Law Strengthening (Announced in August 2000 and Implemented in July 2001) on the Choice of Utility Model Patenting by Chinese and Western Firms