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Kenneth Guang-Lih HUANG
Singapore Management University, kennethhuang@smu.edu.sg

Xuesong GENG
Singapore Management University, xsgeng@smu.edu.sg

Heli WANG
Singapore Management University, hlwang@smu.edu.sg
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Institutional Regime Shift in Intellectual Property Rights and Innovation Strategies of Firms in China

Kenneth Guang-Lih Huang,[a] Xuesong Geng,[b] Heli Wang[b]

[a] Division of Engineering and Technology Management and Department of Strategy and Policy, NUS Business School, National University of Singapore, Singapore 117575; [b] Lee Kong Chian School of Business, Singapore Management University, Singapore 178899

Contact: kennethhuang@nus.edu.sg (KGH); xsgeng@smu.edu.sg (XG); hlwang@smu.edu.sg (HW)

Abstract. This study develops a novel 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 to the extent that Chinese firms have been deeply embedded in China's informal institutions, they are less responsive to formal institutional changes than Western firms operating in China. Using the major China patent law reform of 2001 as an exogenous event, we find results consistent with our key arguments: With the strengthening of the previously weak (utility model) patent protection, Chinese firms are less likely to apply for such patents to safeguard their innovations than Western firms. However, this difference becomes less pronounced in regions with higher quality intellectual property rights and legal institutions that foster research and development and innovation, and when Western firms gain longer operational experience in China. This study advances our understanding of the intricate interaction between formal and informal institutions and specifically how "stickiness" may arise in their substitutive relationship because of the embeddedness of firms in informal institutional environments. It also provides important implications for policy and innovation strategies for policy makers and firms in emerging economies.

Keywords: intellectual property rights • innovation strategy • institutional change • emerging economy • China

1. Introduction

How institutions influence organizations' strategic responses, such as their innovation behaviors, 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, p. 3), formal institutions represent structures of codified rules and standards. Conversely, informal institutions are enduring systems of noncodified normative and cognitive understanding, socially constructed practices, and social relations that shape the behavior of and interaction among individuals or organizations (Granovetter 1985, North 1990, Scott 1995). These formal and informal institutions define both constraints on and opportunities for economic actions and shape organizational decision making and strategic outcomes (Hiatt et al. 2009, Peng and Luo 2000, Tolbert et al. 2011, Webb et al. 2009).

A change in formal institutions can influence reward and sanction structures in an economy and have important impacts on firms' strategic behaviors (DiMaggio and Powell 1983, Hirsch 1975, Tolbert et al. 2011). For example, improved formal institutions for intellectual property rights (IPR) in a host country affect the country's innovation positively through the increase of inward foreign direct investment in research and development (R&D) (Khoury and Peng 2011), the improvement of industrial development in host countries (Branstetter et al. 2011), international technology transfer, and firms' innovative output (Branstetter et al. 2006, Helpman 1993). As another example, major changes in banking law in an emerging market to promote greater savings and foreign investment are found to have an important impact on firms' acquisition and diversification behaviors (Perez-Batres and Eden 2008).

However, what has been underexplored in the literature is how firms' response to improved formal institutions may be influenced by their embeddedness in the existing informal institutions. This issue is especially pertinent for firms operating in transitional economies and developmental states that have been relying heavily on informal institutions but are undergoing a substantial transformation in formal institutions in the meantime (Evans 1995, Peng 2003). Previous studies indicate that formal and informal institutions are substitutive: generally, when formal institutions are weak and inefficient, firms tend to rely more on informal institutions (Batjargal et al. 2013, Holmes et al. 2013, Webb et al. 2009, Xin and Pearce 1996). On the other hand, when formal rules are clearly stipulated and effectively enforced in developed countries, informal

institutions tend to become less crucial in economic activities (e.g., Branstetter et al. 2006). Extending this logic, one would anticipate that as formal institutions improve in these transitional economies, firms respond more to formal institutions and thus rely less on informal ones (e.g., Ahlstrom and Bruton 2006, Child and Tse 2001, Guthrie 1998). This prediction, however, fails to take into consideration the complexity of the substitutive relationship between formal and informal institutions. To the extent that the embeddedness of firms in the existing informal institutions may increase the inertia or resistance of firms in adapting to the environmental change (e.g., Greenwood and Hinings 1993, 1996; Oliver 1991; Zucker 1991), firms with differential institutional embeddedness may respond differently to the improvement in formal institutions—more deeply embedded firms may exhibit greater "stickiness" in their response. Yet, this logic has remained largely underinvestigated in prior studies on the substitution between formal and informal institutions. An understanding of such intricacy in the interaction between formal and informal institutions in the emerging economies has important policy and strategy implications for firms operating there.

One of the main objectives of this paper, therefore, is to fill this gap by integrating the streams of work on institutional embeddedness of firm and strategy (e.g., Hitt et al. 2004, Oliver 1991, Furman and Stern 2011) into the literature on the interaction between formal and informal institutions. We are interested in studying how an improved formal institution's effect on firms' strategic responses may vary depending upon the differential embeddedness of firms in informal institutions. To do this, we examine the impact of an exogenous change in formal IPR institutions in China on the differential responses of Chinese firms and Western firms operating in China. China implemented one of the most significant amendments in its IPR laws in 2001, after which its IPR legal framework substantially improved and better converged with international IPR regulations. This exogenous "shock" provides an ideal context to unravel the effects of a formal institutional change on strategic responses of firms. In addition, we examine the first-order effect of the IPR law change on the difference in patenting strategies of Chinese and Western firms operating in China, given their differential embeddedness in China's informal institutions. We argue that because of China's relative weakness and inefficiency in formal institutions and Chinese firms' deep embeddedness in informal institutions, Chinese firms tend to resolve conflicts associated with innovative activities by resorting to informal institutional norms and practices, which emphasize the avoidance of direct conflict and respect for authority and relationships. By contrast, Western firms are generally less embedded in China's informal institutional environment but more accustomed to and rely more on formal rules and regulations. We thus predict that, all else equal, domestic Chinese firms may not be as responsive to changes in formal institutions (e.g., formal IPR laws) as Western firms operating in China.

While the difference in the embeddedness in informal institutions is most pronounced between local Chinese firms and Western firms, variations are possible in such embeddedness, which would moderate the first-order effect if our argument is valid. Thus, we further investigate these variations. First, Chinese firms may have differential embeddedness in informal institutions across regions. In regions with relatively high de facto institutional quality, Chinese firms' relative embeddedness in informal institutions is lower compared to that in other regions. As a result, their responses to IPR change are expected to be stronger than those in regions with low de facto institutional quality. Second, Western firms may increase their embeddedness in China's informal institutions with an increase in their operational experience in China. Therefore, we argue that the difference in responses to IPR change by Chinese and Western firms is smaller (i) when the technologies are developed in regions with higher de facto institutional quality for fostering and protecting R&D and innovation, and (ii) when Western firms have accumulated more local experiences and knowledge as their operational experience in China increases.

This study seeks to make the following contributions. First, we extend prior research on substitution between formal and informal institutions by proposing that greater embeddedness in informal institutions leads to stickiness in firm response to an improvement in formal institutions, hence enriching our understanding of the dynamics of the substitutive relationship. In particular, we suggest that firms' deep embeddedness in informal institutions may cause organizational resistance and insensitivity to changes in formal institutions (e.g., Greenwood and Hinings 1996, Peng 2003). Firms may be "locked" in their prevailing (informal) institutional environment, which might reduce the firms' propensity to adopt new formal institutions. Thus, even as formal institutions strengthen, the potential substitution effect of formal institution for informal institution may be constrained for more deeply embedded firms than for less embedded ones. As such, we identify important contingencies under which the substitutive effects may be reduced or strengthened over time.

Second, we conceptualize how firms may seek alternative protection against expropriation in innovations through informal institutional approaches, norms, and informal *guanxi* networks (or personalized connections or relationships of influence) (Granovetter 1985, 1993;

Uzzi 1996) that deeply characterize the Chinese society and its transitional economy. Previous studies consider how entrepreneurs and firms acquire critical resources given the complex interaction between formal and informal institutions (e.g., Batjargal et al. 2013, Hiatt et al. 2009, Hitt et al. 2004, Holmes et al. 2013, Tonoyan et al. 2010). We add to this line of research by suggesting that firms can leverage informal institutions as an alternative means to formal institutions in the protection of their intellectual property assets, especially in the emerging economy context.

Third, we complement previous research which focused on variation in institutional environments across countries at specific points in time (e.g., Batjargal et al. 2013, Hitt et al. 2004) by examining the temporal and spatial effects of institutional change within a country on firms' innovation strategies. To do this, we incorporate a novel research design using transnational China–U.S. patent dyads and exploit a major, top-down IPR law reform in China as an exogenous event which, together with appropriate controls, can help mitigate to a certain extent concerns of reverse causality and endogeneity that have hindered some previous strategy studies in this area.

2. Theory and Hypothesis 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, p. 3). 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 of a society (Hiatt et al. 2009, Hiatt and Park 2013, North 1990, Scott 1995).

When disputes or malfeasance arise from the interactions between individuals or organizations in a society, they can resort to either formal or informal institutions for resolution (North 1990). The informal institutions—the norms, practices, and networks that embody them—are characterized by trust, personal ties, and shared expectations instead of contractual agreements as in formal institutions (Asanuma 1985, Dore 1983, Evans 1996a, Gerlach 1992, North 1990, Smitka 1991). Resolution through informal institutions relies more on long-term cooperative relationships (Dore 1983, Romo and Schwartz 1995) instead of maximizing economically rational goals and immediate financial gains. Thus, informal institutions enable opportunities that cannot be easily obtained through the market or legal transactions (Hiatt et al. 2009, Tolbert et al. 2011). At the same time, informal institutions influence and constrain the choice and behavior of individual and organizational decision makers through their cognitive and normative considerations (DiMaggio and Powell 1983, Granovetter 1985, Hiatt and Sine 2014, Hirsch 1975, Scott 1995).

On the other hand, formal institutions are the formal codified rules and standards that 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). 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).

2.1. China's Formal IPR Institution and IPR Reforms

The legal and regulatory protection of IPR, such as patent laws, is one of the most important aspects of formal institutions (Acemoglu et al. 2001, Huang and Murray 2009, North 1990). Intellectual property rights facilitate firms' innovative activities by providing protection against expropriation, therefore increasing the incentives for firms to innovate and grow (Hu and Png 2013, Levin et al. 1987, Nordhaus 1969). Compared with the developed Western countries that have long established clear and strong legal protection of IPR, emerging economies such as China suffer from institutional inadequacies (Ginarte and Park 1997, Huang 2017). Although the Chinese IPR system has been in existence for more than two decades (since 1985) and has undergone reforms, it is a relatively young system that requires further improvements compared with the long-established IPR system in the developed Western nations (Huang 2010).

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] The 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 rights protection (with little ambiguity), 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 United States because the U.S. Patent and Trademark Office (USPTO) does not issue such patents. Moreover, the 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. No substantive examination is required for the utility model patent and therefore it is quicker, easier, and also slightly less expensive to obtain 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, somewhat less expensive to obtain, and not as strong in terms of the duration of protection as the invention patents, their property rights, enforcement, and review procedures have been substantially clarified and strengthened (e.g., Stembridge 2010).

2.2. Informal Institutions in China and IPR Protection

As formal institutions in China tend to be weak and inefficient, Chinese firms rely more on informal norm-based approaches and *guanxi* to take advantage of their deep embeddedness in China's informal institutions (Batjargal et al. 2013, Holmes et al. 2013, Webb et al. 2009). This is exacerbated by the uncertainties in the change of formal institutions during China's major transition to a market-orientated economy, which force managers to seek solutions in informal institutions (Peng 2003, Peng and Luo 2000, Xin and Pearce 1996). In particular, the Chinese market is characterized by complex interdependence among multiple weak institutional forces. When there is a confluence of multiple weak and inefficient formal institutions (Batjargal et al. 2013, Ostrom 2005), the institutions for rule making and enforcement become diffused, difficult to identify, and sometimes contradictory (Batjargal et al. 2013, Seo and Creed 2002). This reduces the effectiveness of any formal institution. Furthermore, rather than the formal rule of law (or *fazhi*; North 1990), Chinese society has long been accustomed to the norm of the "rule of man" (or *renzhi*; e.g., Backman 1999), which emphasizes respect for authority and informal networks, *guanxi*, in governing the harmonious relationship between society members who value avoidance of open conflict (e.g., Chai and Rhee 2009, Xiao and Tsui 2007). Together, the inefficiency in formal institutions and cultural norm for conflict avoidance enhance the firm's reliance on informal institutions to better navigate in complex environments (e.g., Batjargal et al. 2013). As a result, there is an increased need for informal coordination among institutions, typically through authorities or informal networks.

In general, firms can benefit from being embedded in informal institutions through their relationships with exchange partners or other social actors (e.g., Granovetter 1985) and connections to public officials (Evans 1996a, b). These informal networks support how the informal rules, norms, cultural frames, and practices are shared and persist (DiMaggio and Powell 1983, Scott 1995). Firms' embedded relationships in such informal institutions regulate the expectations and behaviors of exchange partners in the social structure through trust building, fine-grained information exchange, and joint problem solving (Granovetter 1985, Uzzi 1996). Prior studies have found in different contexts that greater institutional embeddedness heightens empathy (Batson 1990), improves solutions to coordination problems among networked partners (Bazerman and Neale 1992), or prevents opportunistic behaviors of firms as a governance mechanism (e.g., Gulati 1995). Moreover, strengthening connections with public officials enables firms to trespass the public (state)–private boundary for better public–private cooperation and access to and accumulation of valuable social capital (Evans 1996a, b). Through such connections, firms gain better access to knowledge about how to get things done in state agencies and can better resolve issues jointly with state agencies. This knowledge enables firms to navigate bureaucratic agencies, understand their actions, enhance shared goals and interests, and increase trust with the bureaucrats (Tsai 2007, Wank 1999, Yang 2005).

In the context of China, firms may benefit from informal norm-based approaches, connections, or *guanxi* primarily in two ways. First, informal norms and *guanxi* improve firm's access to bureaucratic officials for critical resources (Ayyagari et al. 2010, Xin and Pearce 1996) or to reduce institutional uncertainties in norm-based bureaucratic interventions (Batjargal

2010, Batjargal et al. 2013). For example, Chinese firms have leveraged informal *guanxi* networks to help persuade bureaucrats to lighten the regulatory load, provide relief from taxation and fees, ease the acquisition of resources such as bank loans and land-use rights controlled by the state, and enhance legal oversight to avert predatory behavior (Chen and Dickson 2010, Lin 2001, Nee and Opper 2010). Second, in a society that values adherence to social norms (Chen 1995, Earley and Gibson 1998, Xiao and Tsui 2007), informal ties among Chinese firms may also serve as deterrents to deviating behaviors (e.g., Chai and Rhee 2009).

Particularly for the protection of IPR in China, prior to the establishment of the Chinese patent system in the mid-1980s, the concept of IPR was largely unrecognized and there was a lack of formal protection of intellectual assets in China. Even after the mid-1980s, formal IPR protection is still very inefficient, and there is significant interdependence among different institutions with diverse and sometimes conflicting goals and functions in the protection of intellectual assets. In China, an IPR 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 in different levels of governments). During China's transition from a planned to market-based economy, as judicial enforcement is relatively weak and ineffective, central and provincial governments play a substantial role in overseeing the operation of markets and the interaction among 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 infringement on 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. Firms' informal connections to government officials can facilitate bureaucratic arbitration through negotiation, mediation, and resolution of IPR conflicts among disputing firms outside the courts without undertaking formal litigation procedures.

Personal and informal connections to the government can, therefore, be useful in resolving IPR infringement through greater insider information and enhanced coordination among multiple bureaucratic units (e.g., Tsai 2007, Wank 1999, Yang 2005). The presence of multiple complex, interdependent departments and administrations necessitates and fosters greater embeddedness of Chinese firms in China's informal institutions and hence provides more room for firms to seek norm-based, nonstandard bureaucratic approaches and informal networks to coordinate among these interdependent agencies. These practices provide more leeway for firms to utilize personal or political *guanxi* and social norm-based approaches to influence the outcome of the conflict resolution (e.g., Ang and Jia 2014). Despite a gradual improvement in the formal legal system, these informal approaches have remained popular in China (Tang 2009).

The following example of a patent infringement case illustrates the above point and reflects a common phenomenon in China. The main infringed patent is named Diesel Engine Manual Free Starter (SIPO utility model patent CN2828351), which was applied for in 2005 and granted in 2006 to a firm in Xinxiang city, Henan province (SIPO 2008a). Upon detailed review and investigation, the city government's IPR official discovered that many companies had already obtained sizable manufacturing scale by exploiting and infringing upon the patent. Under such circumstance, advancing the inventing firm's interest by implementing the patent law strictly could lead to the potential closure of these infringing companies and dismissal of thousands of employees. Instead of using formal litigation through courts, the firm engaged the help of the Xinxiang city government through its informal connections. The bureaucratic units of government considered the economic implications and the diverse goals of interdependent agencies. In consultation with the firm, the city government's IPR official adopted a norm-based approach and worked with the firm 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 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 by other companies while sharing technical and marketing resources and codeveloping the technological product. While no formal patent litigation was carried out, the inventor and the firm derived substantial financial and technological benefits from these arrangements and practices. The example illustrates that compared to judicial enforcement of patent protection, the norm-based approach is more popular and flexible, and therefore deemed more feasible and effective by firms that have access to it.

In sum, because of the traditional lack of efficient and effective formal institutions, many Chinese firms' strategies and economic activities have been well embedded in the Chinese informal institutions that allow them to advance their private interests and optimize performance (Meyer and Rowan 1977, DiMaggio and Powell 1983, Oliver 1991). As a result, Chinese firms tend to rely more on informal norm-based approaches instead of formal legal protection of their intellectual property assets against expropriation.

2.3. Institutional Embeddedness, IPR Reforms, and Firms' Patenting Choices

Here, we investigate how the level of firm embeddedness in the (strongly informal) institutional environment in China may influence the firms' patenting strategies and responses to major changes in the formal IPR institutions. Based on research on institutional embeddedness of firms, deep embeddedness in the prechange institutional context may lead to organizational and structural inertia in adapting to the new institutions (e.g., Evans 1995, Greenwood and Hinings 1996, Peng 2003). Embeddedness in a particular institutional context may lead to the formation of a template or archetype that shapes the organizational structures and practice (Greenwood and Hinings 1993). The change of organizational template in response to institutional change would be difficult and slow (Greenwood and Hinings 1996). The better the fit the firms have with the existing institutional context, the more difficult it is for them to successfully transform themselves (Peng 2003). Institutional values and norms are anchored in regular organizational thoughts and practices, and may cause managerial cognitive difficulty in realizing the necessity of change and how to change (e.g., Kogut and Zander 2000). Accordingly, greater institutional embeddedness gives rise to greater stickiness or inertia for firms to change. The institutionalized practices, routines, and structures become an "institutional baggage" for firms to carry and cause resistance to change (Roth and Kostova 2003; Zucker 1991, p. 105). Moreover, firms tend to utilize and accentuate their strategies that have been successful under the old institutional configuration but may lack the capabilities required to adjust and fit into the newly changed institutional environment—such as a strengthening of formal institutional regime—further increasing the cost incurred in adapting to the new institution (Perez-Batres and Eden 2008). As such, firms deeply embedded in the existing institutional environment may try to maintain the status quo, hoping to "muddle through" the new institutions with minimal changes (Peng 2003, p. 285).

Furthermore, the level of embeddedness varies among firms operating in China. The largest difference can be observed between two groups of firms: local Chinese firms and Western firms operating in China. As discussed in the previous section, before the IPR reform, the confluence of multiple weak formal institutions led Chinese firms to rely more on informal institutions for alternative solutions to IPR protection. Deeply embedded in and familiar with such informal institutions, Chinese firms may still attempt to leverage their embedded relationships, access valuable resources, and gain help from bureaucratic agencies or regulatory authorities for IPR protection and joint problem solving even in the new IPR regime (Guillen 2000, Uzzi 1996). Moreover, their existing capabilities that fit well in the informal institutions may be less useful or optimal under the new IPR regime that requires skills and expertise in legislation for IPR-related issues. As a result, Chinese firms' reliance on informal institutions remains "sticky," even as the formal IPR regime strengthens, making Chinese firms reluctant to change their patenting strategies.

In contrast to Chinese firms, Western firms are expected to be more sensitive to the changes in formal IPR protection. First, they traditionally attach greater importance to formal rules and regulations in their home countries (Branstetter et al. 2006, Grossman and 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. Furthermore, given the developed formal institutions in their home countries, these Western firms have developed and optimized their skills and expertise in using legislation for IPR protection (Caeldries 1996). These firms can more easily adapt to and apply those skills and expertise to their operations in China under the strengthened formal IPR regime. Second, as they have developed their organizational routines to suit the developed institutions of their home countries, these routines can constrain them from effectively embedding in and adapting to the complex and sometimes ambiguous institutional environment in China, especially before the IPR regime improvement (e.g., Kostova and Zaheer 1999). Third, Western firms may be subject to the liability of foreignness, which suggests that firms face greater social and economic (transaction) costs when they operate in foreign markets (e.g., Kostova and Zaheer 1999, Mezias 2002, Zaheer 1995, Zaheer and Mosakowski 1997). Given their foreignness, they may lack understanding of local norms and resources to access the informal network and build a long-term relationship with state bureaucrats and government agencies.

In sum, compared to local Chinese firms, Western firms are less embedded in the (informal) institutional environment in China and therefore have less access to alternative solutions provided by the informal institutions for IPR protection. As such, Western firms rely more on the development of formal institutions of IPR protection in China. It follows that when there is a strengthening of the IPR regime in the host country, we predict a greater increase in the likelihood of adoption of patents with improved protection such as the utility model patent by Western firms than by Chinese firms. Therefore, we predict the following:

Hypothesis 1. *Upon the strengthening of IPR law, the increase in the likelihood of a utility model patent application being made for a technology is smaller for Chinese firms than for Western firms.*

2.4. Variation in Embeddedness Due to the De Facto Quality Of the IPR System Across Regions

While the difference across firms in their embeddedness in China's informal institutions is most pronounced between local Chinese firms and Western firms operating in China, there are additional variations in such embeddedness. These variations might lead to further differences in firms' responses to changes in formal institutions. We first focus on the variation in embeddedness due to the different de facto quality of IPR systems across different regions of China.

Although China's formal IPR institutions are quite weak in general (Huang 2017, Zhao 2006), which reinforced Chinese firms' greater reliance on informal institutions, different regions in China are not equal in their degree of development in formal IPR and legal institutions. Since the opening up of China in the late 1970s and early 1980s, there have been systematic differences across regions in the development of the legal system and appreciation of formal laws. As a result, the de facto quality of the IPR and legal systems across different regions of China varies significantly. For example, in some of the inland provinces of China such as Guizhou, Qinghai, Shaanxi, and Yunnan, formal institutions for IPR protection and enforcement are not very effective (Fan et al. 2010). The IPR courts and legal systems in these regions are weak and often influenced by local administrative agencies. Here, greater institutional embeddedness can promote commitment and joint problem solving among firms and local administrative agencies, and allow Chinese firms to access the social capital across the state–private divide. This enhances the successful dealing with inefficient formal institutions to provide more effective IPR protection. As a result, firms conducting R&D in these regions tend to rely more on informal approaches for the protection of their innovation outputs.

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 traditionally inherited stronger legal infrastructure and court systems and a deeper appreciation for the rule of law. They have developed more robust formal IPR institutions (Du et al. 2008, World Bank 2008). In these regions, if firms rely primarily on embedded ties in informal institutions, they could be insulated from the more effective market mechanisms and possibilities, hindering firm performance (Uzzi 1997). Furthermore, compared with those in the inland 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. These better developed formal institutions help to reduce Chinese firms' reliance on informal norm-based approaches to protect their R&D outputs and innovations.

Given firms' various strategic considerations, their R&D activities 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 locations where the firms conduct their R&D (Fan et al. 2011, Wang et al. 2007).[3] 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. The informal institutional environment affects Chinese firms much more than Western firms given Chinese firms' embeddedness in and greater reliance on local informal institutions. Such tacit knowledge and understanding resulting from the confluence of formal and informal institutions are heavily imbued with meaning arising from the social and institutional contexts in which that confluence is produced. They are difficult to transmit over long distances and, hence, spatially sticky (Gertler 2003).

As such, although China has weak IPR institutions in general, and thus Chinese firms are overall more embedded in China's informal institutions, some Chinese regions historically developed higher de facto IPR quality than others. Firms that conduct R&D in those different regions may vary in their embeddedness in informal institutions. Chinese firms operating in regions with high de facto IPR quality are less embedded in China's informal institutions. They are thus expected to be more responsive to the IPR regime shift, a behavior that departs from other Chinese firms operating in regions with low IPR quality but one that comes closer to 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 2. *Upon the strengthening of IPR law, the difference in the likelihood of utility model patent applications being made by Chinese firms and by Western firms for technologies is smaller for technologies developed in regions with higher de facto IPR quality.*

2.5. Variation in Embeddedness Due to Western Firms' Experience in China

In this section, we examine the variation within Western firms in their embeddedness in China's informal institutions as a result of their differential operational experience in China, even though they are, on

average, less embedded compared to their Chinese counterparts.

Because 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 and Chi 1999). While Chinese cultural/philosophical traditions cannot be easily transplanted to Western firms, Western firms may be able to learn and potentially assimilate informal norms and practices 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 and Zander 1993). These efforts allow earlier Western entrants to better embed in and take advantage of China's strong informal institutions.

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 implications of this transition (Luo 2007, p. 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. These foreign firms are rewarded for conforming to the host-country institutional environment as institutions create pressures for the adoption of social patterns and norms (DiMaggio and Powell 1983, Kostova and Zaheer 1999). This requires foreign firms to appreciate and improve adherence to China's social norms and practices (e.g., Strutton and Pelton 1997). Localization to the domestic knowledge pool and cultivation of an interorganizational relationship with the domestic business community are also important for foreign firms to develop innovative competence (Almeida and 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 and Zander 1993, Pan and Chi 1999). They are more likely to have accumulated experiences dealing with IPR 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 (Granovetter 1985, Uzzi 1996). Thus, we postulate that the longer a Western firm operates in China, the more likely the firm and its strategies have been embedded in and adapted to China's informal institutional norms and practices. The Western firm may behave more like a domestic Chinese firm in resolving IPR-related conflicts.

Hypothesis 3. *Upon the strengthening of IPR law, the difference in the likelihood of utility model patent applications being made by Chinese firms and by Western firms for technologies is smaller for Western firms with longer operational experience in China.*

3. Methods

3.1. Empirical Context and Approach

Although China is the largest emerging economy in the world, it has a relatively young IPR system, which started in 1985, and, in general, a weak formal IPR environment (Huang 2017, Zhao 2006). Compared with developed Western countries that have long-established, clear, and strong formal IPR regimes, emerging economies such as China suffer from institutional inadequacies (Ginarte and Park 1997). To bring its patent law closer to the WTO requirements and to further harmonize its patent law and IPR standards with international rules such as the TRIPS agreement—which China adopted in 2001 as part of its WTO obligations in its accession to the WTO—China has undertaken substantial efforts in recent years to strengthen and harmonize its IPR legal framework through major IPR reform, such as the 2001 patent law amendment. This particular top-down reform in IPR law, designed and implemented by the central government, was influenced by the exogenous change in China's national policy to align with WTO standards and the TRIPS agreement. Although accompanying China's accession to the WTO might have been some general expectation that more changes in IP regime would take place over time, this particular IP reform and its details were not disclosed until the announcement on August 25, 2000 (which came into effect on July 1, 2001), and hence were relatively unexpected. Table 1 summarizes the 2001 China patent law amendment. Such an exogenous event allows us to better isolate the impact of strengthening and clarifying the 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 and provides a suitable setting for testing our theoretical predictions.

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 August 25, 2000, and effective on July 1, 2001; top-down reform	
Objective	To promote the development and innovation of science and technology
Motivation	Membership into World Trade Organization Patent law fully in line with TRIPS agreement Enhance 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).

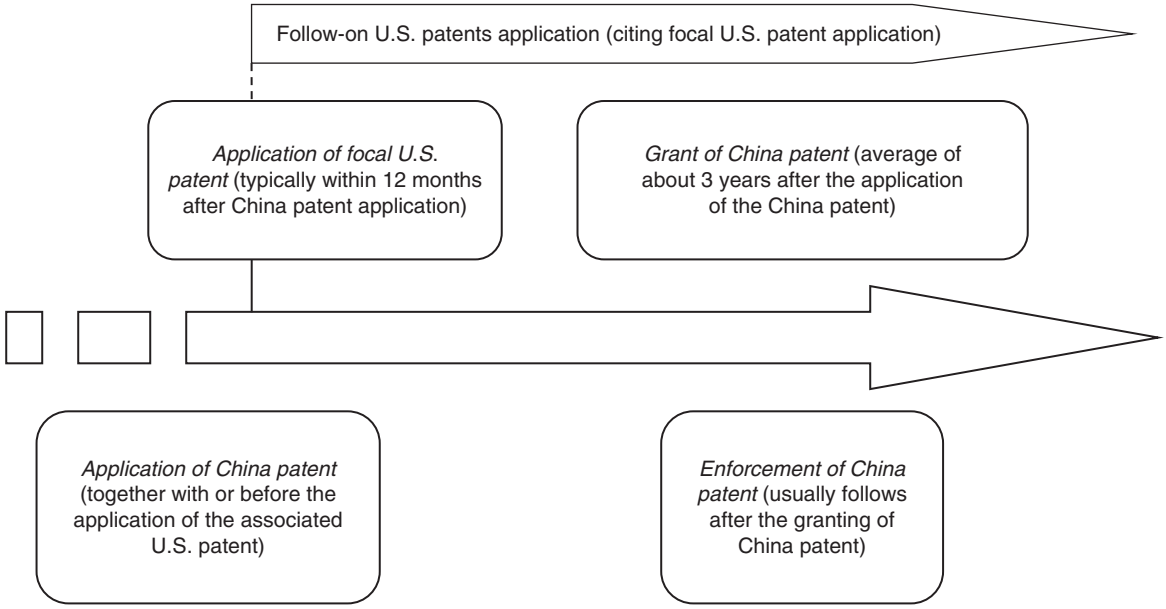
Our study focuses on comparing Chinese and Western firms' shifts in patenting strategies on technologies of international importance. Such technologies should be developed in China, and also be of strategic importance in the face of global competition. Moreover, they should provide a common platform 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 for by and awarded to Chinese and/or Western firms for the same inventions in China and in the United States from the years 1985 to 2008. We chose the United States because it is the largest and the most technologically sophisticated market in the world and is the leading choice of country in which to obtain a patent for firms with technologies of international interest and importance. This sample captures all China-originated technologies for which patents were applied for in China and the United States (through SIPO and USPTO, respectively) and subsequently granted in both countries.

Our final sample consists of 1,070 patents granted both in China and in the United States to 430 unique Chinese and Western firms that operate and conduct R&D in China.[4] The SIPO patents were applied for by these firms from 1985 to 2006 and granted from 1986 to 2007; the USPTO patent counterparts were applied for 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 China–U.S. patent dyad covering the same invention filed both in China and the United States. 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 or her successor in title and allows him or 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.[5] When filing a 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 precisely link a Chinese patent to its U.S. counterpart. The priority right for patents usually lasts 12 months. The timeline in Figure 1 illustrates the relationship between a typical Chinese patent and its U.S. counterpart.

Furthermore, 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 nonobviousness of both the SIPO and USPTO.[6] These inventions developed in China are also important enough to the firms to be patented in the United States, the largest and most technologically sophisticated market in the world. Consistent with previous studies (Jaffe et al. 1993, Murray and 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 could be absent.

Second, as the USPTO awards only invention patents, whereas the SIPO awards both invention and

Figure 1. Relationship of a Typical Chinese Patent and Its U.S. Patent Counterpart and Follow-on U.S. Patent Citations



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 firms in the United States, 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 United States and granted a USPTO invention patent.[7] This natural variation, together with controls for the legal strength, scope, quality (or value), and technology sector of the patents, helps mitigate the concern that a utility model patent is simply filed because the associated technology is inferior.[8] Thus, our focus at the patent level enables a richer and more nuanced observation of and control for the above-mentioned characteristics of each patented technology. As well, this setup allows us to control for firm attributes at the aggregated firm level. The larger number of observations at the patent level also provides greater statistical power to our empirical tests.

3.2. Data Sources

We drew our data from the following five different sources: (1) Data on the U.S. patents, citations, and patent characteristics are derived from the USPTO. (2) Data on the Chinese patents, citations, and patent characteristics are obtained from the SIPO. (3) Data on IPR quality and legal protection of each of the 31 Chinese provinces, municipalities, and autonomous regions are assessed using the relevant indices developed by the National Economic Research Institute (NERI) of China, as described in its 2011 report (Fan et al. 2011).[9] Although this information is only available from the year 1997 onward, it is reasonably stable and consistent over time across provincial-level regions in China, as validated by prior studies (Li and Qian 2013, Wang and Qian 2011). (4) Data on firms' operational experience in China and years since founding are manually collected from official firm websites and firms' annual reports. (5) Data on whether the firm is publicly listed are obtained from Compustat Global Data, supplemented by information from official firm websites and annual reports.

3.3. Measures

3.3.1. Dependent Variable. Our dependent variable is captured by an indicator 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 the variable takes on the value 1. The increase in the adoption of utility model patents could arise from either a shift from those technologies that might otherwise have been filed as invention patents, or from those technologies that might otherwise not have been filed for any patents previously.[10]

3.3.2. Independent Variables. Our key explanatory variable is *IPR change in force*. It is an indicator variable that equals 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 whether the firm awarded the patent originates from or is home based in China. *Western firm* denotes whether the firm awarded the patent originates from or is home based

in a Western country.[11] We use either the *Chinese firm* or *Western firm* indicator variable in different models, based on what is required to best test the 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 and Western firms, as suggested by Hypothesis 1.

De facto IPR quality is captured by the average of the number of patent applications and granted patents (for all firms and organizations) divided by the number of R&D or technical personnel in each provincial-level region in China (Fan et al. 2011). Consistent with prior studies (e.g., Fan et al. 2010), this provides a reasonable proxy for the level of IPR protection in each region as it indicates the patenting productivity and incentive of scientific and technical personnel in each region, which are closely associated with stronger IPR protection (e.g., Nordhaus 1969). As an alternative measure of the quality of the IPR legal system, we construct the variable *de facto legal protection*. This variable uses one of the NERI indices computed from surveys to firms and other corporate entities on the effectiveness of legal enforcement and fairness of legal administrations in each provincial-level region for the protection of firms and their assets.[12] Following previous studies (Zhao 2006), a patented technology is considered to be 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* (or, as an alternative measure, *de facto legal protection*) with *IPR change in force* and *Chinese firm* to test the effect of variation in de facto IPR quality across different regions in China, as suggested by Hypothesis 2.

Operational experience 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 nonlinear effect associated with operational experience as the marginal learning effect may decrease as experience grows (e.g., Argote and Epple 1990). We use the interaction among *operational experience in China*, *IPR change in force*, and *Western firm* to test the effect of variation in Western firms' experience in China, as Hypothesis 3 suggests.

3.3.3. Control Variables. We include the following patent-level controls. *Law announcement window* is an indicator variable that equals 1 during the period between 2000 when the IPR law change was announced (on August 25) and 2001 when the law is implemented (on July 1). This variable helps us to account for the noise associated with this particular period from law announcement to actual implementation. *Number of claims* denotes the number of legal claims made by a U.S. patent, which provides a proxy for patent legal strength (Harhoff and Reitzig 2004, Lanjouw and 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 or value of the patented technology (Furman and Stern 2011, Jaffe et al. 1993, Jaffe and Trajtenberg 2002).[13]

Furthermore, we include a set of *technology sector controls*. Based on a large body of literature (Cohen et al. 2000, Hall and Ziedonis 2001, Huang 2010, Levin et al. 1987), is the set consists of six indicator variables each denoting whether a patent belongs to a discrete technology sector (i.e., pharmaceutical or chemical) or to a complex technology sector (i.e., computing, semiconductor, information technology, or communications). Firms can adopt different patenting strategies for technologies in different sectors. Patents in discrete technology sectors may have higher substantive value for product development and protection against expropriation (Huang and Murray 2010, Huang and Ertug 2014, von Graevenitz et al. 2011). Patents in complex technology sectors may have higher strategic value as cross-licensing bargaining chips and for establishing IPR territories (Hall and Ziedonis 2001).

We also include the following firm-level controls. *Private firm* is an indicator variable that is coded 1 when the firm is not publicly listed, that is, has not gone through initial public offering, 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 nonlinear effect of learning associated with this variable. The 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 et al. 2009). Thus, 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 et al. 1993, Murray and 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. In the most stringent models, instead of these firm-level controls,

we include *firm fixed effects* to control for any firm-level unobserved heterogeneity in patenting behavior and preferences. Table 2 shows the descriptive statistics and correlations of these variables.

3.4. Regression Model

As the dependent variable is a dichotomous outcome variable that indicates whether a patent is filed as a utility model patent (i.e., taking on the value of either 1 or 0) while there is no restriction on the values of the independent variables, a logistic regression (or logit model) would be suitable to model their relationship (Long 1997, Hosmer and Lemeshow 2000). The ordinary least squares (OLS) regression model may result in invalid standard errors and hypothesis tests because the errors (i.e., residuals) from the OLS model may violate the assumptions of homoscedasticity and normality of errors of the OLS regression (Long 1997, pp. 38–40). In the logit model, the log odds of the outcome variable are modeled as a linear combination of the predictor variables. In our most stringent logit models, we include firm fixed effects and technology sector fixed effects to control for the potentially unobserved underlying heterogeneity among firms and technology sectors. The fixed effects specification is supported by the result of a Hausman test.

4. Results

Models 3-1 to 3-4 in Table 3 present the results of the fixed effects logistic regression models with the dichotomous dependent variable *utility model patent*. We also incorporate robust standard errors in all the models based on Wooldridge (1999) to account for possible heteroscedasticity and lack of normality in the error terms. Model 3-1 shows the baseline specification with the patent-level, technology sector,[14] and firm-level controls for all observations between 1985 and 2008. Model 3-2 includes the key independent variable, *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 4.48 (equal to exp(1.50), $p < 0.001$) on average for both Chinese firms and Western firms.

Models 3-3 and 3-4 test the differential responses of Chinese relative to Western firms in the odds of utility model patenting after the IPR improvement as predicted by Hypothesis 1. Model 3-3 includes the interaction between *IPR change in force* and *Chinese firm* together with all the controls but excluding firm fixed effects. Results suggest that IPR regime strengthening increases the odds of choosing the *utility model patent* for Western firms by a factor of 10.38 (equal to exp(2.34), $p < 0.001$), but only by a factor of 3.29 (equal to exp(2.34 − 1.15), $p < 0.001$) for Chinese firms. In the most stringent (and our preferred) main model 3–4,

Table 2. Descriptive Statistics and Correlation Matrix

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 *Utility model patenting*	0.38	0.49													
2 *Law announcement window*	0.23	0.42	−0.16***												
3 *IPR change in force*	0.57	0.50	0.39***	−0.06*											
4 *Number of claims*	14.36	9.67	−0.05+	0.00	−0.01										
5 *Number of classes*	4.32	3.24	−0.17***	−0.04	−0.17***	0.10**									
6 *Cumulative citations*	2.40	8.03	−0.11***	−0.08**	−0.25***	0.17***	0.04								
7 *Private firm*	0.86	0.34	0.27***	0.09**	0.32***	−0.02	−0.16***	−0.18***							
8 *Years since founding*	2.49	1.51	0.12***	−0.10**	0.15***	−0.07*	−0.15***	0.03	0.16***						
9 *Lifetime patents*	2,620	10,636	−0.16***	−0.03	−0.15***	0.03	0.07*	0.08*	−0.45***	0.35***					
10 *Chinese firm*	0.74	0.44	0.11***	0.06*	0.28***	−0.17***	−0.02	−0.19***	0.12***	−0.34***	−0.38***				
11 *Western firm*	0.44	0.50	0.24***	−0.24***	0.04	0.23***	−0.03	0.09**	0.03	0.48***	0.27***	−0.66***			
12 *De facto IPR quality*	13.09	4.81	0.07*	−0.01	0.16***	0.08*	−0.02	0.01	0.02	0.06	−0.05	0.08*	0.12***		
13 *De facto legal protection*	5.36	0.97	−0.01	−0.04	0.07*	0.05	−0.02	0.06+	0.03	−0.05	−0.05	−0.05	−0.04	0.76***	
14 *Operational experience in China*	1.78	1.41	0.11***	−0.02	0.35***	−0.14***	−0.10**	−0.13***	0.22***	0.69***	0.10**	0.32***	−0.02	0.10**	−0.05

Note. $n = 1{,}070$.

$^{+}p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Table 3. Logistic Regression Models on the Effects of IPR Law Reform

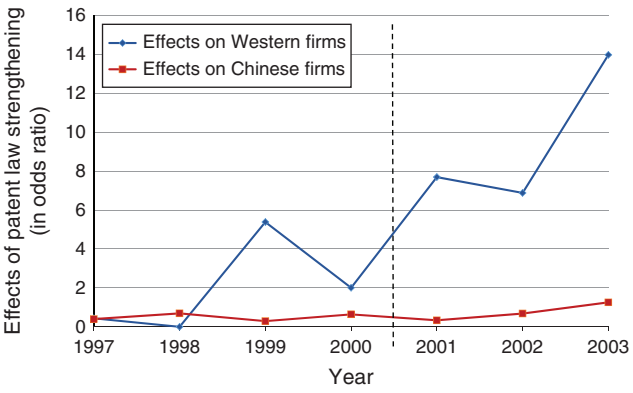
Variables	Model 3-1 Model with controls only	Model 3-2 Model without interaction and without firm FEs	Model 3-3 Model with interaction but without firm FEs	Model 3-4 Main model with interaction and firm FEs
Law announcement window		−0.87***	−0.91***	−5.05***
		[0.25]	[0.24]	[1.17]
IPR change in force		1.50***	2.34***	4.68**
		[0.24]	[0.47]	[1.74]
Chinese firm	0.16	−0.29	0.35	−3.87*
	[0.24]	[0.25]	[0.42]	[1.50]
Number of claims	0.00	−0.00	−0.00	−0.04
	[0.01]	[0.01]	[0.01]	[0.04]
Number of classes	−0.05	−0.05	−0.04	0.05
	[0.03]	[0.03]	[0.03]	[0.06]
Cumulative citations	−0.11***	−0.05+	−0.05+	−0.06
	[0.03]	[0.03]	[0.03]	[0.07]
Private firm	2.00***	1.55***	1.66***	
	[0.46]	[0.47]	[0.47]	
Years since founding	0.21**	0.05	0.07	
	[0.07]	[0.08]	[0.08]	
Lifetime patents	−0.00*	−0.00*	−0.00*	
	[0.00]	[0.00]	[0.00]	
IPR change in force × Chinese firm			−1.15*	−5.37**
			[0.54]	[1.99]
Technology sector controls	Yes	Yes	Yes	Yes
Firm fixed effects (FEs)				Yes
Constant	−2.05***	−1.74**	−2.28***	8.61***
	[0.54]	[0.54]	[0.62]	[1.96]
Observations	1,070	1,070	1,070	342
Pseudo-*R*-squared	0.24	0.30	0.31	0.75
Log-likelihood	−428.18	−391.56	−388.85	−58.06

Note. Robust standard errors are in brackets. All tests are two-tailed.
+$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

which includes patent-level and technology sector controls and firm fixed effects, the difference is even larger; that is, *IPR change in force* has a positive effect on Western firms' adoption by a factor of 108 ($p < 0.01$) compared to no significant increase in Chinese firms (i.e., nonsignificant combined effect). Put differently, the marginal probability of Chinese firms adopting utility model patenting after the strengthening of the IPR law is 0.41 ($p < 0.001$), which is not significantly different from the probability before the law change. By contrast, the marginal probability of Western firms adopting utility model patenting increases to 0.89 ($p < 0.001$) after the IPR law strengthening from 0.64 ($p < 0.001$) before the law change. Taken together, these results support Hypothesis 1.

We 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 law change. To do this, we estimate a logistic regression model including all controls and separate indicator 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 this specification. Whereas a decline

Figure 2. (Color online) 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



for Western firms is observed in the year before the law change, a sharp and continued increase is observed over the three years since 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 since the change.

Table 4 shows models 4-1 to 4-3, which include all patent-level and technology sector controls, as well as firm fixed effects based on the specifications of the (preferred) main model 3-4. Models 4-1 and 4-2 report the results of the testing of Hypothesis 2 by respectively estimating the effects of variations of de facto IPR quality and de facto legal protection across different regions in China. In model 4-1, we include all the two-way and three-way interactions among *Chinese firms*, *IPR change in force*, and *de facto IPR quality*. The coefficient of *IPR change in force* × *Chinese firm* is negative and significant (−306, $p < 0.001$), which again suggests a smaller increase for Chinese firms in utility model patenting than Western firms. However, the positive and significant coefficient (25, $p < 0.001$) of the interaction, *IPR change in force* × *Chinese firm* × *de facto IPR quality*, indicates the difference between Chinese and Western firms will decrease if the quality of regional IPR system increases.

Model 4-2 includes all two-way interactions and three-way interactions among *Chinese firms*, *IPR change in force*, and the alternative measure, *de facto legal protection*. Similar to model 4-1, the coefficient for *IPR change in force* × *Chinese firm* in model 4-2 is negative and significant (−236, $p < 0.001$). However, the positive and significant coefficient (45, $p < 0.001$) of the three-way interaction, *IPR change in force* × *Chinese firm* × *de facto legal protection*, indicates that such difference between Chinese and Western firms will similarly decrease if the regional legal protection increases. Taken together, these results suggest that the difference between Chinese and Western firms' patenting strategies becomes less pronounced when they develop their technologies in regions of higher de facto IPR quality or stronger de facto legal protection. Therefore, Hypothesis 2 is supported.

Model 4-3 reports the results of the testing of Hypothesis 3 by estimating the effects of firms' operational experience in China. As our theoretical focus here is on the variation in the change in patenting strategy among Western firms (relative to Chinese firm) as their operational experience in China increases, we use Chinese firm as the basis for comparison in this regression model. The nonsignificant 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* × *Western firm* (105, $p < 0.05$) suggests that Western firms substantially increase the odds of *utility model patent* after the IPR regime change. However, the negative and significant coefficient (−41, $p < 0.05$) of the three-way interaction, *IPR change in force* × *Western firm* × *operational experience in China*, suggests that such odds difference will decrease as the operational experience of Western firms increases. This suggests that Western firms behave more like their Chinese counterparts as they operate longer in China's informal institutional environment. In other words, the difference between Chinese and Western firms in their changes in patenting strategy after IPR regime shift is smaller for Western firms with longer operational experience in China. Therefore, Hypothesis 3 is supported.

4.1. Supplemental Analyses on Institutional Embeddedness and Stickiness of Firm Responses

To supplement the empirical analyses conducted for Hypotheses 1 to 3, we performed the following two additional analyses by using more fine-grained measures of institutional distances to differentiate Western firms originating from different countries. In particular, instead of putting all Western firms together, we employed formal institutional (legal) distance and informal institutional (cultural) distance, respectively, as two additional proxies for the degree of institutional embeddedness.

For the first test, following our theoretical logic, we argue that firms from countries with stronger formal institutions (i.e., further institutional distance from China) tend to be less embedded in China's (informal) institutions and hence less sticky in their response to the strengthening of the IPR regime in China. So, we investigated the effects of institutional distances between firms from China and those from different Western countries on their responses to the strengthening of the IPR regime. We follow prior studies on institutional distances between countries (e.g., Gaur and Lu 2007, Gu and Lu 2011) and adopt their measures of country-level institutional indicators in terms of legal institutional environments, obtained from the World Bank's Governance Indicators (Gu and Lu 2011). The legal institutional environment consists of indicators on political stability, rule of law, voice and accountability, control and corruption, government effectiveness, and regulatory quality.

To conduct this analysis, we first define and code the continuous variable *legal distance from China* as the difference in the absolute value of the legal environment factor score of each country from that of China (which has the lowest score among the countries in our sample). Given that the legal environment factor score is relatively stable over time, we follow prior studies and take the yearly average for each country (Gu and Lu 2011). We then perform an analysis similar to model 3-4 but substitute *Chinese firm* with *legal distance from China*,

Table 4. Fixed Effects Logistic Regression Models on the Effects of IPR Quality and Operational Experience

Variables	Model 4-1 De facto (regional) IPR quality	Model 4-2 Alternative measure: De facto (regional) legal protection	Model 4-3 Operational experience in China
Law announcement window	−12.50***	−8.63***	−59.27**
	[1.43]	[2.46]	[20.35]
IPR change in force	305.50***	239.34***	0.45
	[3.11]	[20.76]	[3.27]
Number of claims	−0.02	−0.04	−0.03
	[0.04]	[0.04]	[0.04]
Number of classes	−0.02	−0.03	−0.02
	[0.09]	[0.11]	[0.06]
Cumulative citations	−0.06	−0.06	−0.07
	[0.07]	[0.08]	[0.07]
Chinese firm	118.22***	0.99	
	[23.32]	[9.36]	
IPR change in force × Chinese firm	−305.52***	−235.61***	
	[3.11]	[20.33]	
De facto IPR quality	8.47***		
	[1.82]		
IPR change in force × De facto IPR quality	−25.44***		
	[3.68]		
Chinese firm × De facto IPR quality	−8.93***		
	[1.70]		
IPR change in force × Chinese firm × De facto IPR quality	25.35***		
	[3.56]		
De facto legal protection		−1.32	
		[3.36]	
IPR change in force × De facto legal protection		−46.52***	
		[4.36]	
Chinese firm × De facto legal protection		−0.88	
		[1.85]	
IPR change in force × Chinese firm × De facto legal protection		45.47***	
		[4.17]	
Western firm			−151.64***
			[35.71]
Operational experience in China			−2.22**
			[0.80]
IPR change in force × Western firm			105.08*
			[44.51]
IPR change in force × Operational experience in China			0.20
			[0.86]
Western firm × Operational experience in China			80.45***
			[10.92]
IPR change in force × Western firm × Operational experience in China			−41.17*
			[16.33]
Technology sector controls	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Constant	−105.65***	17.14	−55.51**
	[26.00]	[17.51]	[20.76]
Observations	342	342	342
Pseudo-*R*-squared	0.79	0.79	0.79
Log-likelihood	−49.08	−47.87	−48.29

Note. Robust standard errors in brackets. All tests are two-tailed.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

and substitute the interaction term *IPR change in force* × *Chinese firm* with *IPR change in force* × *legal distance from China*. We find the impact of patent regime improvement on firms' response in terms of utility model patent application significantly increases with greater *legal distance from China*. This finding suggests that firms from countries relying on stronger formal institutions (i.e., less embedded in China's informal institutions and hence less sticky) exhibit greater and more positive response to China's IPR law improvement.

For the second test, we look into the effect of informal institutions—such as cultural-philosophical differences—on the differential responses between Chinese and Western firms to IPR law improvement. We suggest that firms from countries with closer informal institutional distance to China tend to share more common cultural values and informal norms. Consequently, these firms tend to be more embedded in informal institutions in China and hence exhibit more stickiness or resistance in their response to China's formal IPR regime strengthening. To operationalize this test, we code Hofstede's (2001) measure of long-term orientation (LTO), also known as "Confucian dynamism," based on the firms' country of origin. Chinese firms' reliance on informal institutions and the "rule of man" (as discussed before) could be partly influenced by traditional culture and philosophy such as Confucianism, which places more emphasis on social norms based on a code of conduct instead of formal rules and regulations. Thus, this measure provides some evidence on the role of cultural–philosophical differences. Despite the limitations of Hofstede culture measures (Shenkar 2001), they have been extensively used in studies on international business (e.g., Tihanyi et al. 2005) and innovation and entrepreneurship (e.g., Shane 1995, Steensma et al. 2000). Particularly, the LTO dimension 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). We argue that firms from countries with more similar LTO values may have less difficulty in learning and embedding into the Chinese institutional environment.

Specifically, to conduct this analysis, we define and code 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 the countries based on the Hofstede (2001) measure. Compared with firms from Asian countries, firms from the United States 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 treat this measure as time invariant in our analysis. We then employ regression models similar to model 3-4 but substitute *Chinese firm* with *LTO distance from China*, and substitute the interaction term between *IPR change in force* and *Chinese firm* with that between *IPR change in force* and *LTO distance from China*. We find that the effect of patent regime improvement on firms' response in terms of utility model patent adoption significantly increases (decrease) with greater (less) *LTO distance from China*. This result shows that firms from countries closer in LTO distance to China have more similar patenting behavior to their Chinese counterparts because they are likely to be more embedded in China's informal institution and hence less responsive to China's formal IPR regime strengthening.

4.2. Robustness 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 and IPR regime change in force periods. To do this, we substituted *law announcement window* with alternative window period controls (e.g., 2000 or 2001) separately in the most stringent model, model 3-4. The results are robust and consistent with that of model 3-4. We also used an alternative IPR regime change in force period (i.e., after 2001) in a regression model similar to model 3–4. The results are robust and consistent with that reported in the main model.

Second, we checked whether 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 an indicator variable that equals 1 for the years from 1993 to 2000 (and 0 otherwise) in models similar to models 3-3 to 3-4 and models 4-1 to 4-3 yielded consistent and robust results.

Third, to provide additional tests for Hypotheses 2 and 3, we performed split-sample analyses to verify whether the first-order effects of IPR law change on the patenting strategies of Chinese and Western firms depend on the variations in (i) the de facto IPR quality of the region in which the firms' technologies are developed and (ii) the operational experience of Western firms in China. To perform the first analysis, we first split the patents assigned to Chinese and Western firms into two subsamples at the median de facto IPR quality across all the provincial-level regions. Using

regression analysis similar to model 3-4 on the two subsamples constructed, we find that, for the subsample of Chinese firms in regions with lower de facto IPR quality, the coefficient of the interaction term *IPR change in force* × *Chinese firm* is negative and significant (−38, $p < 0.001$). By contrast, the effect is positive and significant (13, $p < 0.001$) for the subsample of Chinese firms in regions with higher de facto IPR quality. The difference between the two coefficients is significant, lending further support to Hypothesis 2.

To perform the second analysis, we first split the patents assigned to Western firms into two subgroups at the median *operational experience in China*. Each of the subgroups is then combined with the sample of Chinese firms to form the respective subsamples for analysis. Using regression analysis similar to model 3-4 on the two subsamples constructed, we find that, for the subsample with less experienced Western firms, the coefficient of the interaction term *IPR change in force* × *Chinese firm* is negative and significant (−39, $p < 0.001$). By contrast, the magnitude of the effect is much smaller (−3.19) and not significant for the subsample with more experienced Western firms. The result from this analysis further supports Hypothesis 3.

5. Discussion and Conclusion

The formal intellectual property rights regime provides the rule of law and incentive system to encourage innovation. Policy makers in transitional economies such as China have taken major steps toward standardizing and clarifying such regimes to foster innovative activities. Thus, with the strengthening of IPR protection after China's patent law reform of 2001, we expect firms operating in China to increase their adoption of the improved form of IPR—utility model patents—to safeguard their internationally valuable innovations. We examine important patents applied for and granted to the same technology (by the same firm) in both China and the United States to better account for the quality of such technologies developed in China, and we find support in our empirical results. More intriguingly, we find that Chinese and Western firms in China exhibit a significant difference in their response to the patent law reform. Chinese firms, in general, do not increase their application of such internationally valuable patents (after an improvement in their protection) as much as their Western counterparts.

In this study, we seek to explain the difference in the responses between Chinese and Western firms from an institutional theory perspective. We argue that because of the relatively weak and inefficient formal institutions in China and the complex and ambiguous interdependence between institutional forces, Chinese firms are deeply embedded in China's informal institutions to advance private interest, access political or social capital, and optimize performance. This may result in Chinese firms' stickiness or lack of responsiveness to formal institutional changes as they tend to rely more on informal norm-based approaches and informal *guanxi* networks (Batjargal et al. 2013, Holmes et al. 2013, Webb et al. 2009). This behavioral tendency may be manifested in their resorting less to formal legal litigations and protection mechanisms against the potential expropriation of their innovations compared with Western firms.

Moreover, we find that the difference in the adoption of the strengthened utility model patents between Chinese and Western firms becomes less pronounced with increasing de facto institutional quality of the IPR and legal system in regions where firms conduct their R&D. This finding suggests that although the formal IPR institutions in China are generally quite weak, which reinforces Chinese firms' greater embeddedness in and reliance on informal institutions, Chinese firms are less embedded in the informal institutions in regions with high de facto IPR quality. In those regions, Chinese firms and their strategies are more responsive to and can better take advantage of the clearer formal rules to protect their intellectual assets. Consequently, their response to the formal IPR regime shift becomes more like that of their Western counterparts in those regions.

Furthermore, we find that the difference in the adoption of the strengthened utility model patents between Western and Chinese firms becomes smaller with increasing operational experience of Western firms in China. This finding suggests that although informal norms and practices that advance Chinese firms' private interests and optimize performance are formed over time, they are not completely inaccessible to outsiders. With constant exposure to the norms and practices of their Chinese counterparts and the pressure to conform to the host-country institutional environment, Western firms can better understand and adapt to China's informal institutions through experiential learning. Thus, with increasing operational experience in China, Western firms' patenting strategies to formal IPR regime shift can become more like those of Chinese firms.

This study makes the following contributions. First, we extend prior literature on the substitutive relationship between formal and informal institution by proposing that this is a complex relationship that can be subject to stickiness in firms' response to the change in institutional environment. We substantiate this argument by drawing upon and integrating theoretical perspectives from institutional embeddedness of firms and strategies to suggest that firms' deep embeddedness in informal institutions may cause organizational resistance and insensitivity to changes in formal institutions (Greenwood and Hinings 1996, Peng 2003, Zucker 1991). As such, the improved formal institution does not immediately substitute for, or

reduce a firm's reliance on, the informal institution if the firm has been deeply embedded in the existing informal institutions. Such investigation into the complex substitutive relationship between formal and informal institutions can advance our understanding of firms' heterogeneous responses to the improvement in a country's formal institutions. It might also help explain why certain changes in the formal institutions may face greater resistance than others to take effect. As such, our institutional embeddedness framework supplements the liability of foreignness argument from international business (e.g., Zaheer 1995, Zaheer and Mosakowski 1997, Mezias 2002) and provides more nuanced insights. Indeed, the degree of institutional embeddedness in the local market may constitute an important source of not only the liability of foreignness but also the behavior difference between foreign firms and domestic firms in responding to institutional changes. An implication for emerging economies is that simply transplanting and imposing formal rules that had worked well in the developed economies without consideration of the local context and the intricate interactions between these formal rules and (local) informal institutions may not be the optimal approach to improving the overall institutional environment to encourage innovation.

Second, previous studies consider how entrepreneurs and firms acquire critical resources given the complex interaction between formal and informal institutions (e.g., Batjargal et al. 2013, Hiatt and Sine 2014, Hitt et al. 2004, Holmes et al. 2013, Tonoyan et al. 2010). The literature also emphasizes how a changed institutional environment in relation to normative, cognitive, and regulative dimensions provides new entrepreneurial opportunities, rationales, and necessary resources for firms to exploit (Hiatt et al. 2009, Tolbert et al. 2011). We add to this stream of literature on the substitution effect between formal and informal institutions in emerging economies by suggesting possible mechanisms firms may use to protect their innovations and intellectual assets through alternative informal institutions. Although we find that those firms deeply embedded in the existing informal institutions might be slow in changing their way of conducting R&D and protecting innovation outputs, the process might be different for a firm's resource acquisition during formal institutional changes. This is a potential avenue for future studies.

Moreover, scholars have called for more attention on agency and discretion of organizations to explain the variation in organizational conformity to exogenous coercive change in formal institutions (e.g., Hiatt et al. 2009, Hiatt and Park 2013). The organizational consequences of changes in formal institutions are not always anticipated (Hiatt et al. 2009), and we suggest that the existing informal institutions will play a critical role in influencing the consequences. This perspective can also add to the stream of literature that has used social movement perspective to examine how the informal (i.e., normative and cognitive) aspects of the institutional environments can be influenced by the social movement, and subsequently affect firms' strategic response and entrepreneurial behavior (Sine and David 2003, Tolbert et al. 2011). We have only started to unravel the complexity in how formal and informal institutions interact. Further exploration in this direction will enrich our understanding of the antecedents and consequences of such interaction.

Third, we leverage an exogenous event of a top-down, major IPR law change, which helps mitigate the concern for reverse causality and endogeneity. This study complements prior research in this area, which mostly focused on variation in institutional environment and firm strategies at specific points in time across countries (e.g., Batjargal et al. 2013, Hitt et al. 2004). Our research setting and novel design, including the construction and use of transnational China–U.S. patent dyads, allow us to compare the differences in the temporal responses of Chinese and Western firms to the same exogenous change in formal institution across regions within one country.

5.1. Limitations and Future Research Directions

Our study has several limitations that may present fruitful avenues for future research. First, our interest in the current study lies in understanding firms' innovation and patenting strategies for internationally important and valuable innovations. We operationalize this by analyzing the entire population of Chinese patents with matching U.S. patents assigned to these firms. Furthermore, by focusing on this subset of important and valuable patents, we are able to control for technology quality and filter out "junk" patents. If infringed upon, these more valuable patents, on average, could gain more attention from the firms owning them and from legal enforcement agencies, making them more likely to be enforced through the formal litigation process. To the extent that the protection of more valuable patents is subject to the influence of informal institutions, we expect that the observed effects might be even stronger for less important/valuable patents. In addition, as the United States is the largest and most important and technologically sophisticated market in the world, and as firms typically seek patents in the United States when patenting beyond the country of technological origin (China in this case), we have captured the majority of such internationally valuable inventions. Nevertheless, future studies could extend this approach by including other types of patents granted to the firms and Chinese patents matched to patents from other foreign countries, such as those in Europe.

Second, our study examines regional variation in de facto IPR quality at the Chinese provincial level. The province is China's basic and constant administrative unit by which most economic policies are formulated and economic activities are organized and managed. This measure is also reasonably stable over time and is not highly correlated with other commonly used regional economic development indicators (such as GDP, GDP per capita, or population). Moreover, it has been used and validated in previous studies (Fan et al. 2010). Nevertheless, such classification of de facto IPR quality may still be rather crude. While we have introduced an alternative measure, de facto legal protection based on NERI surveys to firms, future studies could consider another fine-grained measure of local IPR quality, like those at the subprovincial level.

Third, although our study has provided the theoretical logic and framework behind how Chinese firms engage in informal institutional norms and bureaucratic practices to resolve IPR-related conflicts as an alternative to formal institutional protection in IPR, we are not able to directly observe them in the current study. We are also not aware of any such publicly available and reliable data at a disaggregated level in China. We have attempted to mitigate this concern through our supplemental analyses on institutional embeddedness by testing for the effects of governmental and legal institutional distances of Western firms from China and the application of Hofstede's culture dimensions based on "Confucian dynamism" (i.e., LTO). Although such analyses help shed light on the institutional mechanisms and rule out some potential alternative explanations, they cannot eliminate the concern entirely. Future studies could consider collecting and incorporating data directly capturing such informal institutional practices by Chinese firms. The intricacies and dynamics of the interaction—both temporally and spatially—between formal and informal institutions, especially in emerging economies, present an exciting avenue for future studies.

5.2. Policy and Strategy Implications

Our findings have policy implications for the governments of China and other emerging economies that face major regulatory changes. In addition to understanding the importance of technological knowledge protection and firms' governance choices, policy makers can encourage innovative and patenting activities of firms 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 firms, and the quality of local IPR systems, which have a substantial influence on the effectiveness of formal regime reforms. By shedding light on the potential mechanisms that could lead to differential responses by Chinese and foreign firms to formal IPR regime change, this study could offer useful implications for macrolevel innovative activities and help policy makers better assess the effectiveness of IPR policies.

Our findings also have strategy implications for Chinese and Western firms that engage in innovation activities in China. While it may be effective for Chinese firms to rely on China's informal institutions to resolve IPR conflicts in the Chinese market, it could prevent these firms from accumulating experiences and developing capabilities in dealing with formal institutions. These experiences and capabilities are important for Chinese firms to compete effectively in the global arena. On the other hand, Western firms should gain a greater understanding of China's local context, including its informal norms and practices. It may yield long-term benefits like developing better insights of the innovation strategies used by their Chinese competitors and becoming more adept with alternative nonlegal and potentially less costly strategies to resolve IPR-related disputes and protect their intellectual assets in transitional economies such as China.

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Endnotes

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

[2] The level of regional economic development does not always correlate well with and can vary from regional *de facto IPR quality* or *de facto legal protection*. To check, comparing economic indicators such as gross domestic product (GDP), GDP per capita, and population of each of the 31 Chinese provincial regions to their *de facto IPR quality* shows pairwise correlations of 0.65 ($p < 0.001$), 0.77 ($p < 0.001$), and 0.10 ($p < 0.10$), respectively. Comparing *de facto legal protection* with these indicators shows pairwise correlations of 0.42 ($p < 0.001$), 0.52 ($p < 0.001$), and 0.10 ($p < 0.10$), respectively.

[3] We further verified this condition through informal interviews with patent attorneys in China and the United States and legal scholars in leading universities in China such as Tsinghua University. Furthermore, we manually checked a random sample of SIPO utility model and invention patents obtained directly from the SIPO database and did not find any exception to this condition.

[4] 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 United States, Germany, Switzerland, the United Kingdom, France, Canada, Sweden, Italy, Netherlands, Finland, Denmark, Luxembourg, Liechtenstein, Spain, and Norway.

[5] 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.

[6] For example, USPTO patent approval rate dropped from about 72% in 2000 to 44% in 2008 (Wild 2008). The SIPO has a similar approval rate of about 44% for invention patents from 1985 to 2007 (SIPO 2008b).

[7] Our informal interviews with patent attorneys in the United States and China as well as legal scholars at Tsinghua University in China suggest that a technology awarded a USPTO invention patent will usually be able to pass the bar for a SIPO invention patent as well as utility model patent since the USPTO typically has a more stringent patent examination and granting process.

[8] Even in the case that the technology only qualifies for a SIPO utility model patent but not a SIPO invention patent, it should not affect our theoretical prediction or empirical operation. We still expect to observe a higher likelihood of applying for the utility model patent after the improvement in its clarity, legal protection, strength, and enforceability as a result of the IPR regime change. Consistent with our theory, the greater increase in likelihood of application for Western firms than Chinese firms may be due to their differential embeddedness in China's informal institutions.

[9] The NERI index for market development in China consists of several indices covering different government, enterprise, economic, and legal aspects of the Chinese provincial-level regions. It is computed using data from the China statistical yearbooks, reports from the administrations of industry and commerce, and enterprise and household surveys. For more details, please refer to Fan et al. (2011).

[10] We suggest that it may not be necessary to determine the proportion of increase from each possibility as both are consistent with our theoretical arguments that firms respond differentially to improvement in formal protection of IPR; that is, the improvement in the strength, clarity, legal protection, and enforceability of utility model patents after the 2001 IPR regime shift may induce firms to rely more on the utility model patent as a formal IPR protection than other alternative means to safeguard the firms' intellectual assets.

[11] Consistent with prior literature (e.g., Murray and Stern 2007, Jaffe and Trajtenberg 2002), *Chinese firm/Western firm* is an indicator variable that captures whether at least one of the patent assignees is a Chinese firm/Western firm. As a robustness check, we construct an alternative *Chinese firm/Western firm* variable that denotes that all patent assignees must be Chinese firms/Western firms. Analyses using either variable yield consistent and robust results.

[12] As we would expect, the variables *de facto IPR quality* and *de facto legal protection* are highly correlated (0.76, $p < 0.001$). This provides one indication of the consistency of the alternative measure.

[13] Substituting the control variable *cumulative citations* in the main regression models with *cumulative citation without firm self-citation*, which provides an alternative control for the quality (or value) of the patented technology to nonfocal firms (that are not assigned the patent), yields similar and consistent results.

[14] While we label technology sectors in aggregate as technology sector controls in the regression tables, we note that technology sectors are significant in our models. For example, chemical, computing, information technology, and communications are significant in Model 3-3; information technology and communications are significant in Model 3-4. The results suggest that the patenting choice of firms in China is affected by specific technology sectors of the patents.

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Kenneth Guang-Lih Huang is associate professor in the Division of Engineering and Technology Management, and the Department of Strategy and Policy of NUS Business School, National University of Singapore. He received his Ph.D. in technology management and policy from the Massachusetts Institute of Technology. His research focuses on the management of innovation and technology, science policy, open science, institutional theory, and intellectual property strategy, especially in emerging economies like China.

Xuesong Geng is assistant professor of strategic management at the Lee Kong Chian School of Business, Singapore Management University. He received his Ph.D. from the Rotman School of Management at the University of Toronto. His research focuses on the intersection between institutional theory, innovation, and corporate governance. He is interested in research and phenomenon in emerging markets and the digital economy.

Heli Wang is the Lee Kong Chian Professor of Strategic Management in the strategy and organization area at Singapore Management University (SMU). She received a Ph.D. in strategic management from Ohio State University. Prior to joining SMU, she was assistant and then associate professor at Hong Kong University of Science and Technology. Her research focuses on the resource-based view of the firm, strategic human capital, stakeholder management, and corporate social responsibility.