Technology protectionism and the patent system: Strategic technologies in China

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Abstract

The national treatment principle, a centerpiece of many trade-related international treaties, mandates nondiscriminatory application of treaty provisions to nationals and foreigners. In international patent law treaties, the principle prevents countries from free-riding on foreign technologies, thereby preserving incentives for global innovations. Concerns about violation of the principle at the Chinese patent office have been voiced in business and policy circles, but there is little empirical evidence backing this claim. Using data on about half a million patent applications filed in China we find no, or only weak, evidence of anti-foreign bias in the issuance of patents overall. However, foreign applications in technology fields that are of strategic importance to China are four to seven percentage points less likely to be approved than local applications, all else equal. Given the importance of industrial policy in China and the country's strong focus on indigenous innovation and intellectual property, the empirical results provide a case of technology protectionism by means of the patent system.

Keywords: *industrial policy; national treatment principle; patent; technology protectionism; trade-related intellectual property rights*

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1. Introduction

> "Industry representatives express mixed opinions on whether there is *anti-foreign bias* in the issuance or enforcement of patents in China. However, some non-Chinese firms reportedly find it more difficult to obtain patents in sectors that the Chinese government considers of *strategic importance*."
>
> United States International Trade Commission (ITC) 2010, page xviii (italics added)

As with standard trade barriers, intellectual property (IP) rights may be awarded and exploited in such a way as to discriminate against foreign interests (Maskus, 2000). Governments typically want the strongest possible protection in foreign countries in order to maximize returns to domestic firms, and the weakest possible protection for foreign firms in their domestic markets to facilitate free-riding on foreign technologies (Scotchmer, 2004). To prevent such opportunistic behaviors and thereby preserve optimal incentives for global innovation, international IP treaties impose the "national treatment" principle, which states that within each country foreign applicants must receive treatment equal to that accorded to domestic applicants. This principle also ensures that the patent system is not used as de facto trade protection policy.

As far as we can ascertain, Webster et al. (2014) is the only study investigating the practical application of the national treatment principle in the patent examination process. Using a sample of about 50,000 patent applications granted by the U.S. Patent and Trademark Office (USPTO) and filed in the years 1990–1995 at the European Patent Office (EPO) and the Japanese Patent Office (JPO), the authors found that domestic applicants were more likely than foreign applicants to be granted patent protection, all else equal. They take this result as evidence of violation of the national treatment principle.

The present paper is concerned with the situation at China's patent office, the State Intellectual Property Office (SIPO). The claim that the national treatment principle is not being observed at SIPO has been noted in official reports and is regularly echoed in the press.[1] But discussions about unfair treatment of foreign applicants in China have so far focused largely on *enforcement* of IP rights (e.g., Love et al., 2016). Although enforcement is a worthy object of study in its own right, in this matter it may be thought of as a second-order issue. If foreign

[1] For a recent example see "U.S. firm alleges China's government colluded with local competitor", Washington Post, September 13 2015.

applicants are wrongfully denied a patent in the first place, local competitors may legally use, produce, and sell their inventions in the home market. It is thus of primary importance to assess whether the patent system itself, rather than the judicial system, discriminates against foreigners.

This paper tests for anti-foreign bias in the *issuance* of patents at SIPO. The analysis relies on a sample of about half a million patent applications filed at SIPO in the period from 2001 to 2009. We implement two original strategies to control for unobserved heterogeneity. First, we track the grant outcome of more than 1.6 million exact ‘‘twins’’ of patent applications in our sample. These twins are filed in other jurisdictions where applicants also sought to protect their inventions. We use them to form an expectation of the probability of grant at SIPO (i.e., as a pseudo fixed effect). However, because the grant outcome of these twins may also be subject to a home bias, we have developed a test inspired by Aakvik (2001) and Rosenbaum (2002) to assess the robustness of the findings to such bias. The test involves assuming that the pseudo fixed effect is biased and gradually removing bias by altering the grant outcome of the twin applications. Second, we control for potential differences in the quality of patent attorneys by computing the IP law firm's average grant rate for all but the applications of the focal applicant—therefore ensuring that our results are not explained by differences in the quality of the translation into Chinese or any other IP law firm-specific effect.

Results suggest no—or at worst only weak—overall discrimination against foreigners at SIPO. However, foreign patent applications in ‘‘strategic’’ technology areas are about four to seven percentage points less likely to receive a patent grant than similar domestic applications. We identify strategic areas with the help of experts at the World Intellectual Property Organization (WIPO) based in Geneva. We rely on their expertise to link technologies described in the central planners' long-term development plan (SCPRC, 2006) to technology classes listed in the patent documents. Given the importance of industrial policy in China and the country's strong focus on indigenous innovation and intellectual property, the empirical results provide a case of technology protectionism by means of the patent system.

The rest of the paper is organized as follows. Section 2 provides background information on technological planning and the patent system in China. Section 3 describes the empirical strategy and Section 4 presents the data. Section 5 discusses the results of the econometric analysis and Section 6 presents robustness checks. Section 7 concludes.

2. Background

2.1. Central planning of technology development

After Deng Xiaoping became China's leader in 1978, the Chinese government undertook a series of reforms and transitioned to a "socialist market economy." In this context, the government implemented several innovation-related policies aimed to realize Deng's view that Science and Technology (S&T) should be a primary productive force (OECD, 2008; Liu et al., 2011). From the beginning of the 1980s, science and technology—and related industrial policies—were explicitly designed to stimulate the development of advanced technologies for the purpose of freeing China from financial obligations for foreign technologies. These policies included the "Key Technologies R&D Program," the "863 Program"(the State High-technology Program, started in 1986), the "973 program" (the State Program for the Support of Basic Research and Development), and the "Golden Projects" program.

Technology development continues to occupy an important place in the economic planning strategy of the Central Committee of the Communist Party of China. In January 2006, the State Council issued the "National Medium and Long-Term Program for Science and Technology Development 2006–2020" (MLP), whose guiding principle is to make China an innovation-driven nation by "fostering indigenous innovation, leapfrogging in priority fields, and leading the future" (SCPRC, 2006, p. 7).[2]

The MLP identifies priority technology areas and topics that the central planners consider critical for the country's economic and social development. The plan also sets forth a list of ambitious S&T goals to be achieved by 2020, one of which directly concerns IP: gross spending on R&D (GERD) must meet or exceed to 2.5 percent of GDP; dependence on imported technology must fall below 30 percent; and the country must move into the top five countries for the number of invention patents granted to nationals. In fact, IP receives support at the highest level. Hu Jintao, a former president, is reported to have said on many occasions that "competition in the future is competition in IP" (The Economist, 2015).

2.2. The Chinese patent system and the national treatment principle

China joined the WIPO in 1980 and issued its first patent law in 1984. Since then, Chinese patent law has been revised three times—in 1992, 2000, and 2008—to bring it into alignment

[2] The MLP was implemented first through the Chinese Communist Party's 11th Five-Year Guideline (2006–2010) and then through the 12th Five-Year Guideline(2011–2015).

with international standards.[3] The SIPO is a major international player on the patent scene. It became the world's largest patent office in terms of national applications in 2011 and is the second largest, after the U.S. Patent and Trademark Office (USPTO) for international applications (WIPO, 2015).

A landmark change in IP law occurred in 2001, when China joined the World Trade Organization and signed the so-called TRIPs agreement (for Trade-Related Aspects of Intellectual Property Rights). Article 3 of the TRIPs agreement affirms the national treatment principle, stating that "each Member shall accord to the nationals of other Members treatment no less favorable than that it accords to its own nationals with regard to the protection of intellectual property." This provision is a key pillar of international patent law. It was mentioned in the 1883 Paris Convention for the Protection of Industrial Property, to which China became a signatory member in 1984. Numerous scholars consider that the Chinese patent system now largely complies with international standards and does not discriminate against foreign applicants, at least formally (Yueh, 2009; Liegsalz and Wagner, 2013). A priori, there are thus no reasons to expect any difference in the treatment of foreign and domestic applications at SIPO.

2.3. Concerns in the developed world

Several observers in the United States and Europe have raised concerns that China's policies favoring indigenous innovation are hidden forms of technology protectionism. A document from the U.S. International Trade Commission suggests that this "web of interrelated indigenous innovation policies" may work together to favor domestic over foreign companies in the Chinese market, and that such a discriminatory effect could be especially strong for companies operating in sectors considered strategic by the Chinese government (USITC, 2010). The USITC also reports a close link between these measures and infringement of IP rights in China, stating that through indigenous innovation policies China "undermines and displaces foreign IP while promoting its own IP" (USITC, 2010, Ch. 5, p. 8). A USPTO report echoes this view, stating that "numerous commenters articulated the perception that China's patent system, including enforcement mechanisms, benefits Chinese companies at the expense of U.S. and other foreign companies" (USPTO, 2010, p. 5). In a report prepared for the U.S. Chamber of Commerce, McGregor (2010) makes the particularly bold claim that "the [MLP] is considered by many

[3] See Yueh (2009) and Liegsalz and Wagner (2013) for in-depth analyses of the Chinese patent system and its evolution over time.

international technology companies to be a blueprint for technology theft on a scale the world has never seen before''(McGregor, 2010, p. 26).

In light of these concerns, it is legitimate to ask whether one can find traces of discrimination in the patent system and how important such traces are. As far as we can ascertain, little empirical evidence exists.

2.4. Empirical evidence

To the best of our knowledge, two studies investigate anti-foreign bias in the Chinese patent system. Yang (2008) compares aggregate rates of issuance and pendency between international and domestic patent applications at the USPTO and SIPO. The author finds no significant difference in average pendency between national and international applications at SIPO relative to the USPTO but reports evidence of higher rate of issuance for domestic applications at SIPO. However, due to the highly aggregate nature of the data, the author is able to provide only correlational evidence. Liegsalz and Wagner (2013) perform a similar exercise, though at a finer-grained level. They focus on the pendency of applications filed at SIPO between 1990 and 2002 and account for patent-level characteristics. They show that Chinese applicants receive patent faster than foreign applicants and that the difference in the grant lag is particularly strong in technology fields in which China has a relative technological advantage over other nations. However, the study pre-dates China's accession to the TRIPs agreement and is silent on the issuance rate.

3. Empirical strategy

Our empirical analysis seeks to evaluate the extent to which the probability of being granted a patent at SIPO differs for foreign and Chinese applicants, all other things being equal. We pay close attention to the fate of applications that are in areas of strategic importance to China.

3.1. Econometric model

We estimate the following latent variable model with pseudo fixed effect

$$y_i^* = \beta_1 Foreign_i + \beta_2 Strategic_i + \beta_3 (Foreign \times Strategic)_i + \mathbf{X_i}\gamma + c_i + \epsilon_i, \quad y_i = 1[y_1^* > 0]$$

where y_i^* is the latent variable underlying the binary grant outcome y_i of a patent application for invention i (1 if the application is granted, 0 if it is not). The variable c_i is the pseudo fixed effect that captures invention i's ''quality''. As explained further in the next section, we track "twin" applications of invention i in other jurisdictions and we measure c_i as the average grant rate of these twin applications. Literally, c_i captures other patent offices' assessment of the patentability of invention i. The vector variable $\mathbf{X_i}$ includes the constant term and control variables that may affect the probability of a grant at SIPO.

The dummy variable $Foreign_i$ takes the value 1 if the application for invention i is filed by a foreign applicant and 0 otherwise. Finally, the dummy variable $Strategic_i$ takes the value 1 if invention i relates to a technology of strategic importance, as defined in section 3.3. The variables of interest are $Foreign_i$ and the interaction term $(Foreign \times Strategic)_i$. They allow us to test whether patent applications by foreign firms are systematically less likely to receive a grant, all else equal, and whether there is a specific anti-foreign bias in technology fields of strategic importance. We assume that the error term ϵ_i has a standard logistic distribution, but we will also estimate a linear probability model for comparison purposes.

It is important to note that a negative coefficient for β_3 would not necessarily be evidence of a systematic anti-foreign bias in strategic fields. Indeed, the marginal effect of a change in both interacted variables in a nonlinear model is not equal to the marginal effect of a change in the interacted variable (Ai and Norton, 2003). We will use the methodology proposed by Norton et al. (2004) to estimate the magnitude of the marginal effect for the interaction term in an appropriate manner. In addition, the marginal effect for the interacted term may have a different sign for different observations and for different values of the covariates. Therefore, we will also depict the marginal effects for the interaction term over the range of predicted grant-probability scores, as suggested by Hoetker (2007).

3.2. Identification strategy

The core empirical challenge is to properly control for invention quality and, hence, for the baseline probability that a patent will be granted. The term "quality" denotes the technological merit of the invention, which directly affects the probability of grant. As a preliminary step toward establishing quality, we restrict the sample to patent applications with at least one international family member.[4] Patent applications at SIPO by foreign firms form a selected sample of applications—one for which applicants were willing to incur the substantial cost of

[4] A patent family refers to a group of patent applications that are all related to each other by way of one or several common priority filings. A priority filing is the first patent application that was filed to protect an invention.

international patent protection. By contrast, there is no selection in patent applications by locals, leading to a lower average quality. In order to put locals and foreigners on the same level, we impose that all applications in the sample have a "direct equivalent" at selected patent authorities. A direct equivalent is a patent protecting exactly the same invention in a different jurisdiction (Martinez, 2010; de Rassenfosse et al., 2013). One can think of this requirement as similar in spirit to the common support requirement in econometric matching models.

We searched for direct equivalents at seven patent authorities for which we have reliable information: the European Patent Office (EPO), USPTO, the Japan Patent Office (JPO), the Canadian Intellectual Property Office (CIPO), the Korean Intellectual Property Office (KIPO), the Russian Federal Service for Intellectual Property (RFSIP), and the Taiwan Intellectual Property Office (TIPO). These seven offices account for more than 80 percent of total patenting activity outside China.[5] More specifically, we identify one-to-one equivalents: application B is a one-to-one equivalent of application A if B claims A as sole priority (i.e., no merged patent applications) and if A is only claimed by B in B's office (i.e., no split patent applications). In this sense, A and B cover the same technical content and are thus twin applications.

Next, we go one step further and use the average grant rate for these equivalent applications as a pseudo fixed effect (variable c_i in the regression model). The average grant rate informs us about foreign offices' assessment of the patentability of the invention. In other words, the empirical analysis estimates the determinants of the probability of a grant at SIPO, beyond the grant probability expected by looking at other offices' grant decisions for the same invention. Note that our use of the pseudo fixed effect comes with an implicit exogeneity assumption, namely that foreign offices do not discriminate based on the applicant's country of residence. Should they do so, the pseudo fixed effect would be correlated with the variables of interest, leading to a biased estimator. In order to assess the severity of this issue, we will develop an ad hoc test of unobserved heterogeneity inspired by Aakvik (2001) and popularized by Rosenbaum (2002). This test involves assuming that the pseudo fixed effect is biased and gradually removing bias by altering the grant outcome of the twin applications.

[5] Our own computation based on PATSTAT data.

3.3. Identification of strategic technologies

We used the MLP to identify technologies of strategic importance. The plan describes 27 frontier technologies that should constitute the "basis on which future high technologies stem out and emerging industries grow" (SCPRC, 2006, p.33).[6] These frontier technologies fall into eight major technological fields: biotechnology, information technology, advanced materials technology, advanced manufacturing technology, advanced energy technology, marine technology, laser technology, and aerospace technologies.

In order to identify patent applications in these strategic areas, we linked the 27 frontier technologies to specific patent classes. In particular, we worked at the main group level as defined by the International Patent Classification (IPC) taxonomy.[7] The IPC is a hierarchical system for classifying patent applications according to the different areas of technology to which they pertain. The linking of technologies described in the MLP to IPC classes was done in two steps. First, we relied on *IPCCAT*, a tool that allows for automated patent classification based on text analysis.[8] Second, we validated the list with the help of three WIPO experts, which led to some refinements in the classification.[9] In particular, some IPC classes provided by the classification tool were too broad. At the end of the process, we identified 99 strategic main groups out of the 6,812 main groups used to describe the technological content of the patents in our sample.[10]

It is important to emphasize that we do not claim that the MLP is a medium for discrimination. Rather, we use the MLP to infer areas of strategic importance in a consistent manner. As a matter of fact, the MLP is not the first plan designed to support the development of

[6] Frontier technologies are selected in China in accordance with the following principles: (i) representing the development direction of world high-tech frontiers; (ii) having a pioneering role in shaping and developing new industries in the future; (iii) being conducive to industrial technology upgrading and to achieving leapfrogging in development; and (iv) possessing a strong team of talented personnel and a sound R&D basis (SCPRC, 2006, p.33).

[7] For instance, *H04L 1/02* is a complete classification symbol. The section symbol *H* indicates that the patent application belongs to the Electricity section; the class symbol *H04* identifies the Electric communication technique class; the subclass symbol *H04L* specifies the Transmission of digital information field; the main-group level symbol *H04L 1* (formally *H04L 1/00*) narrows down the technological field of the application to Arrangements for detecting or preventing errors in the information received; the last two digits in the complete symbol further limit the domain to technologies detecting errors by diversity reception.

[8] Available at https://www3.wipo.int/ipccat/. IPCCAT's typical precision scores for English patents are about 90 percent at Class level, 85 percent at Sub-Class level and 75 per cent at Main Group level (Benzineb and Guyot, 2011).

[9] We are grateful to Gabriel Berlicki, Zhou Hao, and Lutz Mailaender for having kindly agreed to help us.

[10] The list is available upon request from the authors.

strategic technologies in China. Programs undertaken in the 1990s ("Key technologies R&D Program", the "863 program", "973 program", "Golden Projects") already promoted many of the technological areas that are listed in the MLP, notably biotechnology, telecommunications, and energy.

4. Data

4.1. Data sources and sample

We combined data from four offline and online sources. The main source of data was the EPO Worldwide Patent Statistical Database (PATSTAT, April 2015 edition). PATSTAT contains information on direct equivalents and the grant outcome at the seven selected offices (de Rassenfosse et al., 2014). It also contains most of the patent-level information used in the empirical analysis. Information on the grant outcome at SIPO comes from the INPADOC legal status table, which is an add-on to PATSTAT. We crawled the Google Patent website to recover the number of independent and dependent claims at SIPO, and the number of words per claim. We also crawled SIPO's website to recover data on the attorneys who handled the applications we analyzed.[11]

The sample is composed of applications filed at SIPO by foreign and domestic firms between 2001 and 2009 and that have at least one unique direct equivalent in one of the following patent offices: CIPO, EPO, JPO, KIPO, RFSIP, TIPO, and USPTO. We specifically excluded utility models and design patents. This selection led to a final sample of 477,854 patent applications. The rationale for constraining our sample to applications filed between 2001 and 2009 was twofold. First, including applications filed from 2001 onward ensures that the modifications introduced by the August 2000 amendment to the Chinese patent law to comply with the requirements of the TRIPS agreements were in place and understood by actors involved in the examination process. Second, excluding applications filed after 2009 was necessary in view of grant delays and the resulting data truncation.

4.2. Dependent variable

The variable y_i, labeled *Grant*, takes the value 1 if a patent was granted and 0 if the application was refused or withdrawn. To mitigate further potential bias related to truncation we exclude pending applications from the sample. Such filtering is particularly important in light of the

[11] See https://patents.google.com/ and http://english.sipo.gov.cn/.

fact that foreign applications have longer grant lags (Liegsalz and Wagner, 2013). We also exclude applications for which the applicant never requested examination because, in such a cases, the withdrawal decision was not affected by SIPO's examination process. Thus, the remaining withdrawn applications in the sample are "quasi-refusals" in the sense of Lazaridis and van Pottelsberghe de la Potterie (2007).

4.3. Covariates

As far as the variables of interest are concerned, the binary variable *Strategic* takes the value 1 if a patent application is assigned to any of the relevant IPC main groups identified through the IPCCAT tool, and the value 0 otherwise. The variable *Foreign* reports whether the country of residence of the applicant recorded in the first priority filing is abroad or in China. If a patent application belongs to more than one applicant we consider it as foreign only if none of the applicants resides in China. (Section 6 discusses alternative specifications.)

The regression model includes several control variables that account for patent-specific characteristics that may affect the grant probability of an application:

- Patent family size (*family_size*) accounts for the total size of the patent family to which an application belongs. Inventions covering large patent families are particularly valuable, which may affect the probability of grant. In computing the family size we consider every patent authority for which the information is available in the PATSTAT database and not just the seven patent offices that we consulted in searching for direct equivalents.

- Number of IPC classes (*tot_IPC*) indicates the total number of four-digit IPC classes to which a patent application pertains. Applications covering many IPC classes are supposedly more complex to examine, as they may rely on technologically distinct elements (Lerner, 1994; Harhoff et al., 2003).

- Number of inventors (*nb_inv*) reports the total number of inventors listed in the patent document.

- Number of applicants (*nb_app*) reports the total number of applicants listed in the patent document.

- Revealed Technology Advantage (*RTA*) is a binary variable that reports whether the RTA at SIPO is strictly larger than one. The RTA is computed as the country's share of patents applications filed at SIPO within an IPC class (3-digit level of the IPC classification) over the total share of that country's applications at SIPO. An RTA value above 1 in a specific IPC class indicates that a country is comparatively specialized in the technology sector covered by that IPC class. The rationale for including this control variable comes from Webster et al. (2014), who show that the degree of technological specialization of the applicant's country affects the grant probability of an application.

- Priority application lag (*priority_lag*) reports the lag in months between the filing date of the priority patent application and the filing date at SIPO. The priority date is the closest in time to the actual invention date, and the lag makes it possible to control for the age of the invention at the moment it reaches SIPO. Logically, the lag is 0 if the Chinese application is the priority filing.

- Examination request lag (*exam_request_lag*) reports the lag in months between the date of application at SIPO and the date of the request for examination. Chinese patent law requires the applicant to submit a request for substantive examination within three years of the filing date. As suggested by Palangkaraya et al. (2008) the decision of an applicant to delay examination may be correlated with the quality of an application and, therefore, with the probability of grant.

- Number of independent claims (*nb_indep_claims*) reports the number of independent claims listed in the patent application. Independent claims describe the essential features of the invention and the variable captures the scope of the invention. This datum is missing for less than 1 percent of the patent applications in our sample. In such cases we rely either on the average number of independent claims included in the equivalent applications filed with other patent authorities, or, if this information is not available, on the number of independent claims included in the granted document.[12]

- Number of dependent claims per independent claims (*dep_claims_ratio*) is the number of dependent claims over the number of independent claims appearing in the patent

[12] In this way we recover the number of independent claims for 91 percent of the applications for which the claim information was missing. In the remaining cases, we impute the number of independent claims for the missing observations through a Poisson regression on a set of relevant patent-specific characteristics, including IPC (3-digit), application year, number of applicants, number of inventors, the total number of IPC codes assigned to the patent application, and the country of residence of the first-listed applicant.

application. A dependent claim limits the scope of the independent claim to which it refers.

- Number of words per claim (*words_claim*) reports the total number of words per claim included in the patent application. A larger number of words per claim signals narrower claims.

- Experience of the applicant (*experience*) is a binary variable that takes the value 1 if a foreign (Chinese) applicant has applied for at least three (two) patent applications at SIPO during the study period, and 0 otherwise. It indicates whether the applicant has some level of familiarity with the Chinese patent system. The different thresholds for Chinese and foreign filings allow us to identify applicants in the upper quartile in terms of number of applications at SIPO for both groups.

- The *pseudo fixed effect* reports the average grant rate of the twin applications.

- IP law firm (*law firm*). China patent law stipulates that a foreign applicant having no residence in China must appoint a licensed IP law firm to act as its agent to handle the patent application. Chinese applicants may instead appoint any IP law firm. The quality of the IP law firm may affect the probability of grant, especially if there are differences in the quality of attorneys between IP law firms chosen by foreigners and locals. The IP law firm effect for patent i by applicant f is computed as the average grant rate of all but applicant f's patent applications processed by the IP law firm. This implementation ensures that the variable is not endogenous to applicant f or to the quality of invention i.

- Dummy variables for the application year at SIPO (*appln_year*) and the 1-digit level of the IPC class(es) of the application (*IPC_class*).

4.4. Descriptives statistics

Table I displays the descriptive statistics by applicant country of residence for the 477,854 applications in the sample.

[Table I about here.]

As the bottom row of Table I shows, applications by Chinese firms represent 4.2 percent of the applications in the sample. This low number attests to the fact that the majority of applications by Chinese firms target the local market. Such filtering is very strict, but it increases comparability between applications by Chinese firms and applications by foreign firms. The table also shows that 73.6 percent of applications by Chinese firms were granted patent protection by SIPO, against 70.8 percent for applications by foreign firms. Strategic IPC subclasses cover about 34.5 percent of applications by Chinese firms and 20.8 percent of applications by foreign firms—even though strategic classes represent only 99 out of 6,812 total classes.

On average, applications by foreign firms belong to larger families and have more IPC subclasses assigned to them, but they list a lower number of applicants and inventors. The time lag between the priority date and the application date is shorter for applications by Chinese firms compared with foreign firms. Indeed, many applications by Chinese firms are priority filings. Interestingly, applications by Chinese firms are associated with shorter examination-request lags than filings by foreign firms, although the difference is only 1.5 months. On average, applications by foreign firms have the same number of independent claims as applications by Chinese firms (about three). However, the former have 1.5 more dependent claims per independent claim and 5.3 fewer words per claim.

The pseudo fixed effect is significantly higher for applications by foreign firms than for Chinese firms, although the effect is small in magnitude (2.4 percentage points). The average grant rate of the IP law firm is not significantly different between foreign and domestic applications.

[Figure 1 about here.]

Figure I shows the distribution of all applications in the sample by 1-digit IPC code and applicant country of residence. The distribution across IPC codes is roughly similar between Chinese and foreign applicants, with the exception of the H class (electricity), which is more prevalent in the case of Chinese applicants.

5. Results

5.1. Baseline results

Table II presents results from the econometric analysis. Note that we rely on a strict 1 per thousand probability threshold for declaring statistical significance, as advised by Johnson

(2013). We log-transform the variables *family_Size*, *tot_IPC*, *nb_indep_claims*, *dep_claims_ratio* and *word_claims* to account for their skewness.

[Table II about here.]

Odd-numbered columns in table II report the coefficients obtained using the linear probability model, whereas even-numbered columns display the marginal effects at sample means obtained using the logit regression model. The first two columns display the results when the control variables are not included in the regressions. Columns (3) and (4) report the results for the full model, which includes the control variables, the pseudo fixed effect, and the law firm effect. Columns (5) and (6) report the results for the regression model estimated on a matched sample of applications to further increase comparability between groups. We matched applications by Chinese firms to applications by foreign firms using the propensity score matching method (Rosenbaum and Rubin, 1985). Applications were paired based on the predicted probability of an applicant being from a foreign entity. We computed this probability by estimating a probit regression model of the variable *foreign* on the relevant application-specific characteristics described in section 4. Given the abundance of foreign applications in our original sample, we matched each Chinese application to up to two control foreign applications. Appendix A discusses the matching procedure in greater detail.

Models in column (1) and (2) provide evidence of low levels of overall discrimination against foreigners, and a greater level of discrimination in technology domains that the Chinese government deems strategic. Controlling for additional confounding factors in columns (3) and (4) reduces overall discrimination to negligible levels but leaves the effect of discrimination in strategic areas essentially unchanged. Estimating the full model on a matched sample of applications in columns (5) and (6) considerably reduces the sample size but confirms the finding of discrimination in strategic areas. Overall, the probability of grant for applications from foreigners in strategic areas is between 4 and 7 percentage points lower that what it should be in the absence of discrimination.

As discussed in Section 3, the marginal effect for the interaction term in a nonlinear model may have a different sign for different observations and for different values of the covariates (Ai and Norton, 2003). The left side of Figure II displays the median spline plot of the interaction effect as a function of the predicted probability of grant. The right side of the figure depicts the interaction effect divided by the predicted probability of an application being rejected. As the left-hand graph shows, the effect is always negative and is strongest in magnitude for applications that have a lower predicted probability of being granted. Discounting the interaction effect by the probability of a rejection leads to the right-hand graph where the (relative) impact of the interaction term is stronger for applications with a higher predicted probability of being granted.

[Figure 2 about here.]

5.2. Technology-specific estimates

To shed more light on the foreign bias we also run the analysis by stratifying the variable *Strategic* and the interaction term by the eight macro-technological areas identified in the MLP: biotechnology, information and communication technology (ICT), advanced materials technology, advanced manufacturing technology, advanced energy technology, marine technology, laser technology, and aerospace technology.

Figure III depicts the results for the macro-areas for which we find a statistically significant effect. The figure reports the effect of the interaction term and the 95%-confidence interval recovered both from the linear probability model and the logit regression model. Foreign applications in the biotech, ICT, and advanced energy fields drive the main result presented in column (4) of Table II. Foreign applications in the field of biotechnology have a particularly low probability of being granted patent protection in China, between 14 and 15 percentage points lower than what they would achieve if the national treatment principle were being observed. For laser technology we also find a negative effect of 10 percent although it is not statistically significant. There is no effect for advanced materials, advanced manufacturing, and marine technology. Finally, the effect in aerospace is positive but not significantly different from zero.

[Figure 3 about here.]

6. Robustness checks

6.1. Standard-essential patents

As described in section 3, we define an application as strategic if it falls into one of the IPC main groups that we linked to the priority technologies described in the MLP (SCPRC, 2006). This approach makes sense, because Chinese industrial policy focuses on selected key technologies. The fact that we find a significant effect further validates it. The approach has the advantage of encompassing a "broad" set of technologies. However, too broad a set might dilute the strength of the discrimination that we find—hence our measure of the foreign bias represents a lower bound estimate of the true effect. We use so-called standard-essential patents (defined below) as a narrower definition of strategic to study how much larger the discrimination could be. More specifically, we run a robustness check in which we identify and separate patent applications in strategic sectors and standard-related applications at SIPO.

In the early 2000s China began to consider technical standards as a crucial tool for improving its innovative capacity (Ernst, 2011). The Chinese government committed to transform the country from a "standards taker" to a "standards maker" through the development of unique Chinese technology standards (SCPRC, 2006). Even though the implementation of fully Chinese standards has not been successful from the commercial viewpoint, some observers have noted that China uses technology standards as a protectionist trade tool (Breznitz and Murphree, 2013). In fact, the Chinese standards administration states such a view explicitly (Ernst, 2011). In addition, Western observers are also concerned that "Chinese competition authorities may target for investigation foreign firms that hold [patents] that may be essential to the implementation of certain standard technologies"(USITC, 2014, p. 35).

Many standard-setting organizations require members to disclose patents or patent applications that are, or have the potential to become, essential to a standard. These patents are defined as standard-essential patents (SEP), with the term "essential" meaning that a given standard cannot be implemented without infringing on a patent declared as SEP for that standard (Baron and Pohlmann, 2015). Standard-setting organizations typically require members to timely disclose their SEPs in publicly available declarations. We identify SEPs by linking patent applications in our sample to the Searle Center's Database of declared standard-essential patents (Baron and Pohlmann, 2015).[13] This database provides one of the most comprehensive lists of declared SEPs currently available.

In this way we were able to identify 2,132 patent applications in our sample that were declared as essential to a technology standard. Most of these applications belong to the ICT domain, and 88.5 percent of the declarations were made for standards developed by the Eu-

[13] We are grateful to the authors for having shared their data.

ropean Telecommunications Standards Institute (ETSI). We include in the regression model a binary variable (*SEP*) that takes the value 1 if a patent application is declared as standard-essential and the value 0 otherwise. We then include an interaction term between the variable *SEP* and the variable *foreign*. We also redefine the variable *strategic* as "*strategic (not SEP)*" and give it the value 1 only if an application belongs to a strategic IPC and is *not* declared as standard-essential. Table III reports the results obtained using this specification.

[Table III about here.]

As the table shows, applications by foreigners related to SEPs have a particularly low probability of being granted, with an anti-foreign bias ranging from 9 to 14 percentage points, depending on the regression model. The effect for the interaction term between the *foreign* and the *strategic (not SEP)* variables is negative and significant; its magnitude is comparable to the one we obtained from the baseline specification. Thus, the discrimination bias may be as high as 14 percentage points.

6.2. Sensitivity to hidden bias

An original feature of the empirical analysis presented here is that we use the grant outcome of direct equivalent applications at different patent authorities as a pseudo fixed effect, which allows us to control for the "quality" of the invention by providing a benchmark for the grant probability at SIPO. However, the pseudo fixed effect may lead to biased estimates of the coefficients associated with the variables of interest if foreigners face positive discrimination in their home office. For instance, a twin application at the USPTO filed by a U.S. applicant may have a higher probability of receiving a grant than a non-U.S. application, all else equal.

To assess the sensitivity of the results to this potential bias we developed a test inspired by the bounding approach proposed by Aakvik (2001). Aakvik introduced the bounding analysis to evaluate the sensitivity of the results obtained through matching estimators to selection on unobservables. The main idea of this methodology is to ask how much hidden bias can be present in the selection process before the qualitative conclusions of the study begin to change. The methodology involves artificially adding increasing levels of hidden bias in the selection and observing when the treatment effect ceases to be significant. A study is highly sensitive to hidden bias if the main results change for small amounts of hidden bias.

Our robustness test is inspired from Aakvik's methodology. We investigate two potential sources of hidden bias. First, we assume that the average grant outcome at other patent authorities is biased upward for home applicants. We then gradually decrease the bias by switching the grant outcome from 1 to 0 for a randomly selected share of twin applications granted by the home office of the foreign applicant, compute again our pseudo fixed effect, and re-run the analysis. We progressively change the grant outcome for 1 to 30 percent of the twin applications of the foreign filings at SIPO that were granted by the home authorities. Second, we also run the test by switching the outcome of granted twin applications in strategic sectors only—although there is no theoretical ground for believing that the home-bias effect at other patent offices should occur only in sectors considered strategic by China.

Table IV reports the coefficient associated with the interaction term $foreign \times strategic$ estimated using the linear probability model for different levels of hidden bias. As the table shows, when the bias is introduced for all foreign applications, the main effect of the interaction term is robust to a very high level of hidden bias. When we selectively introduce the bias exclusively for foreign twin applications in strategic sectors, the results appear to be robust to a reasonable amount of hidden bias. The coefficient is still negative and significant for a level of hidden bias in excess of 25 percent.

[Table IV about here.]

Finally, we also run the analysis using three alternative strategies to compute the pseudo fixed effect. First, we calculate it by discarding the grant outcome at the home patent authority. This version of the pseudo fixed effect is extreme because it discards a large amount of information. Second, we compute it by taking into account the stringency of the pertinent patent authorities. In concrete terms, we calculate the pseudo fixed effect as a weighted average of the grant outcomes at other authorities, where the weight is the reciprocal of the overall grant probability at a specific patent office. In this way we put a higher (lower) weight to successful applications granted by more (less) stringent patent authorities.[14] Third, we recover the pseudo fixed effect by discarding information from the Taiwan Intellectual Property Office,

[14] For instance, the pseudo fixed effect for an application with two granted international twin at the USPTO and at the EPO, instead of being equal to one, will be equal to *[(1/.68) + (1/.41)/2]*. Where .68 and .41 are the average grant probability respectively at the USPTO and at the EPO computed based on all the twin applications in our sample at each of the offices.

which arguably may be too closely aligned with the outcome at SIPO.

Table V displays the coefficient retrieved from the linear probability model for the main variables of interest for the three different versions of the pseudo fixed effect. As the table shows, the effect of the interaction term is always negative and is significantly different from 0 at the 0.001 probability threshold. It ranges between 4 and 7 percentage points, which is quantitatively similar to the baseline specification.

[Table V about here.]

6.3. Sensitivity to applicants' country of origin

The variable *Foreign* takes the value 1 when the country of residence of the applicant is abroad and the value 0 if the country of residence is China. Sometimes, however, large multinational corporations that have subsidiaries in several countries may decide to file a patent application from a local office and not from headquarters. As a result, patent applications by the same corporation could sometimes be categorized as Chinese and sometimes as foreign. In addition, the variable *Foreign* takes the value 1 only if all applicants reside outside China. This strict definition of foreignness may represent a confounding factor if an application by Chinese and foreign co-applicants is treated more like a foreign application than a Chinese one.

To ensure that our results are robust to these issues we run three different specifications. First, we assign applicants to a country only if at least 80 percent of their patent applications list that country as their residence. If the 80 percent threshold is not met, the applications are excluded from the sample. Second, we manually remove from the sample (i) all the applications filed by well known non-Chinese multinational corporations that are listed as Chinese applications and (ii) all non-Chinese applications filed by established Chinese multinationals.[15] Third, we exclude from the original sample all applications co-filed by a foreign and a Chinese applicant.

Table VI reports the coefficient for the main variables of interest recovered from the linear probability model run on the three subsamples. Column (1) displays the results for the sample obtained under the 80 percent rule; column (2), the results obtained by excluding known multinationals; and column (3), the results obtained by excluding Chinese-foreign co-filings. As the table shows, the main finding is very robust to these alternative definitions of foreignness.

[15] For instance, Taiwanese companies frequently file applications through their Chinese subsidiaries.

[Table VI about here.]

6.4. Grant outcome at the USPTO

Some observers may interpret our results as evidence that the MLP is achieving its purpose: Chinese firms do produce higher-quality inventions in strategic fields thanks to the MLP, which logically translates into higher grant rates compared with foreigners. Such an observation neglects the fact that we control for confounding factors using the pseudo fixed effect, the IP law firm effect, application-level characteristics, and a matching approach. However, the concern that the empirical strategy does not fully account for unobserved heterogeneity warrants further investigation.

We ran a robustness test in which we reversed the setting of the analysis: we looked at the grant outcome at the USPTO for the direct equivalents of the focal patent applications at SIPO. Out of the 477,854 filings at SIPO used in the main analysis, 362,439 had a direct equivalent application at the USPTO.[16] Clearly in the new setting we could not include exactly the same set of control variables as in the main analysis. We lacked information about the number of independent claims in U.S. applications and the U.S. patent attorney. Moreover, we could not control for the lag between the application and the request for examination, because no request for examination is needed in the U.S. patent system.

If the higher quality of Chinese applications in strategic sectors were driving the result of the focal analysis, we should find a positive and significant effect on the grant probability at the USPTO for Chinese applications in strategic IPCs. Table VII reports the results of this robustness check. Columns (1) and (2) display the result for the grant outcome at the USPTO (linear probability model and logit), when we compare Chinese applications with filings by applicants of any other nationality. Columns (3) and (4) show the results for the comparison between Chinese and non-Chinese filings, excluding applications by U.S. nationals that may distort the results owing to a potential home-bias effect at the USPTO. As the table shows, when we consider applicants of any nationality we find no significant difference in the grant probability between Chinese and non-Chinese applications in strategic fields. When we remove applications filed by U.S. applicants we find that Chinese applications in strategic fields have a significantly lower probability of receiving patent protection at the USPTO than applications made by other

[16] 78.6 percent of the filings by Chinese applicant and 75.7 percent of the application by foreign applicants in our original sample have a direct equivalent at the USPTO.

nationals. Evidence from the USPTO thus suggests that, if anything, applications by Chinese firms in strategic IPCs are of lower, not higher, quality compared with applications by non-Chinese firms.

[Table VII about here.]

7. Concluding remarks

Most of the political efforts in international IP law as it relates to China has been geared toward harmonizing the legal framework and ensuring better enforcement of registered rights. Governments have indeed made considerable progress on these fronts, but subtler barriers may remain. The patent prosecution process may be one such barrier: Patent offices have wide discretionary power, and, where patents are concerned, policy makers do not verify the observance of the national treatment principle as they do for trade. One reason for this neglect is that discrimination in the patent prosecution process is difficult to identify.

The results presented in this paper seem to confirm the view that the patent system works as a barrier to entry in sectors that the Chinese government considers strategic. The analysis rules out many potential explanations for the effect, notably differences in the quality of the underlying invention. We also took the conservative approach of controlling for the quality of patent attorneys in order to rule out the possibility that results may be driven by foreign companies relying on lower-quality attorneys or having poor translation into Chinese. In fact, discussions with several heads of IP at western companies in these strategic sectors suggest that IP managers work with high-quality local attorneys. Thus, the reasons for the discrimination that we observe are not to be found among the applicants or the attorneys. What remains is the patent office.

This paper does not provide evidence of organized—that is, intentional—discrimination. It was suggested to us that our results may be a consequence of the assignment of more-experienced examiners to strategic applications by foreigners, causing such applications to receive more exacting treatment.[17] This explanation, if confirmed, would imply a systematic difference in the treatment of locals and foreigners in apparent violation of the national treatment principle.

[17] Although this would contradict U.S. evidence that experienced examiners are more lenient than less experienced ones (Lemley and Sampat, 2012). Note that we are not in a position to determine whether foreign applications are being unduly denied or, conversely, whether Chinese applications are being unduly granted.

The results reported here have implications for firms and governments. Firms may not have sufficient perspective or cases to realize that they are being discriminated against. The systematic discrimination undercovered in the empirical analysis suggests that firms in strategic areas should adapt their patenting strategy—for example, by foregoing patenting in China or by filing more and narrower applications covering the same basic invention. Our finding also calls for action at the policy level. Currently, no committee monitors the practical application of the national treatment principle in the prosecution process—in stark contrast to the situation with international trade. In light of the evidence presented in this paper, the formation of such a committee may be warranted.

Appendix A. Matching procedure

As described in section 5, to increase the comparability between the groups of foreign and Chinese patent applications we adopted the propensity score matching model (Rosenbaum and Rubin, 1985). The propensity score is the predicted probability that a given application has been filed by a foreign applicant. To compute that probability (our "propensity score") we run a probit regression of the variable *foreign* on the set of observable application-specific characteristics described in section 4.[18] Given the abundance of foreign applications in our sample, we match each Chinese filing with up to two foreign applications. To ensure that we do not introduce any additional bias by including more than a single control unit, we also set a tolerance threshold for the maximum distance, in terms of propensity score, between matched units.[19]

For the matching procedure to be successful, the empirical distribution of the relevant covariates should be balanced, and no significant differences in the covariates' means should be found after the pairing (Caliendo and Kopeinig, 2008). Table VIII reports descriptive statistics by country of residence for the matched sample and the t-test for differences in the covariates' means between the two groups. As the table shows, there is no significant difference for the vast majority of covariates. Of particular importance is the fact that there is no significant difference between the Chinese and foreign applications for our *pseudo fixed effect* in the matched sample.

The difference is still significant for the *family_size*, the *nb_applicant*, and the *RTA* variables, although the matching procedure has been able to drastically increase comparability between groups (cf. Table I). For instance, the difference in the average family size between foreign and domestic applications is 2.3 for the full sample and only .17 for the matched sample. The same holds for the difference in the average number of applicants, which goes from .12 in the full sample to .03 for the matched sample. The difference also shrinks for the RTA variable, but less remarkably. Note that we include the matching covariates as control variables in the main regression models.

[18] All else equal, for Chinese applications it is much more likely that the filing at SIPO coincides with the first priority application. We thus do not take into account the variable *priority_lag* in the matching procedure, as the country of residence directly affects the probability of the application being filed at SIPO first.

[19] To perform the matching procedure we use the Stata module PSMATCH2, developed by Leuven and Sianesi (2015). The caliper option that determines the maximum distance threshold is set to .25 of the standard deviation of the propensity score as recommended by Rosenbaum and Rubin (1985)

[Table VIII about here.]

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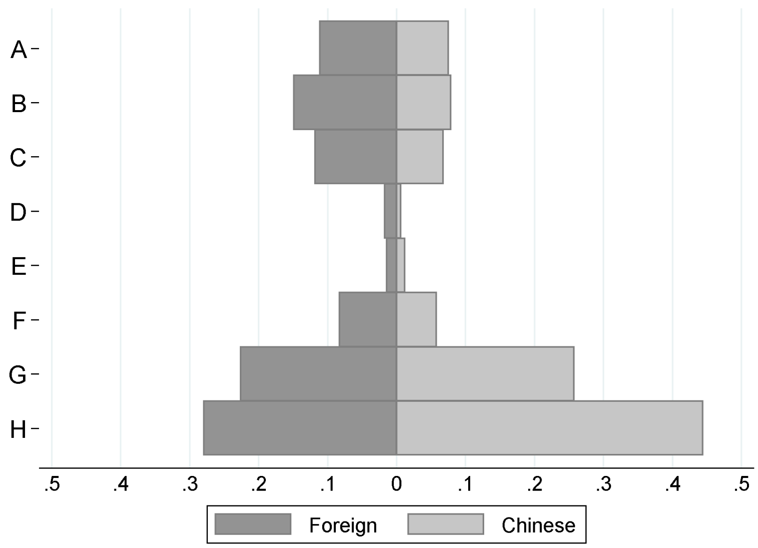
Figure I: Distribution of SIPO applications by 1-digit IPC code and country of residence



A: Human Activities; B: Performing Operations; C: Chemistry/Metallurgy; D: Textiles/Paper; E: Fixed Constructions;F: Mechanical Engineering;G: Physics; H: Electricity.

Figure II: Average interaction effect by grant probability

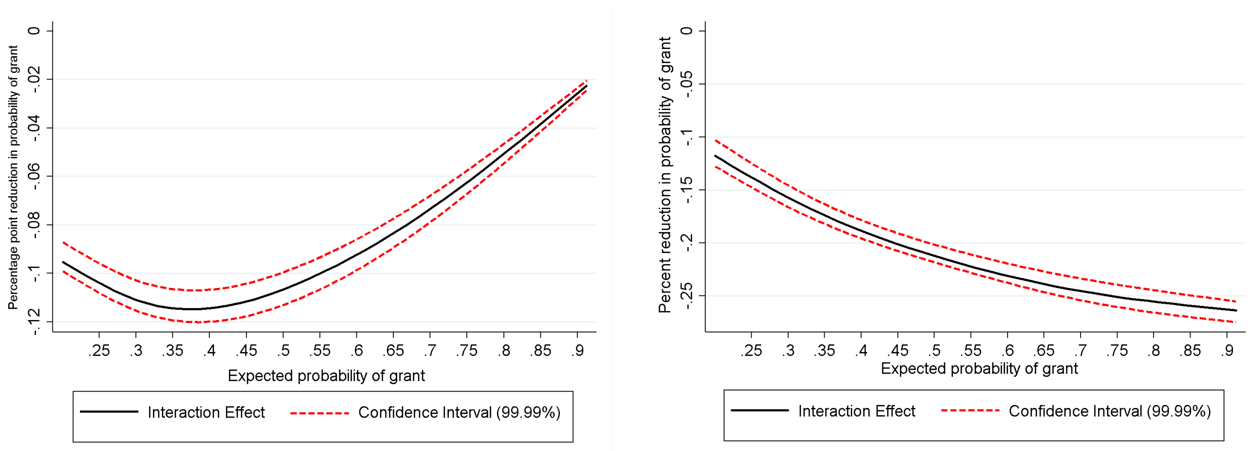
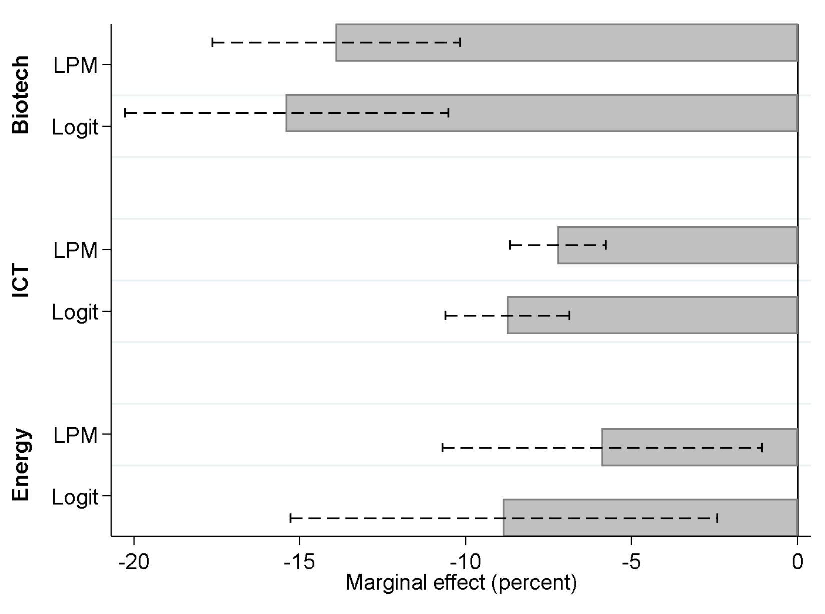


Figure III: Effects for the main macro-technological areas



The dashed line represents the 95 per cent confidence interval

Table I: Descriptive statistics by applicant origin

	Chinese applicants				Foreign applicants				t-test
	min	mean	max	sd	min	mean	max	sd	Diff.
grant	0.0	0.736	1		0.0	0.708	1		0.028*
strategic	0.0	0.345	1		0.0	0.208	1		0.137*
family_size	2.0	3.017	21	1.659	2.0	5.325	65	3.143	-2.308*
tot_IPC	1.0	2.479	15	1.312	1.0	2.667	21	1.531	-0.188*
nb_inv	0.0	2.436	20	1.861	0.0	2.223	33	1.638	0.213*
nb_app	0.0	1.145	7	0.370	1.0	1.029	13	0.200	0.116*
RTA	0.0	0.662	1		0.0	0.636	1		0.026*
priority_lag	0.0	0.995	20	3.120	0.0	10.719	63	2.964	-9.725*
exam_request_lag	3.0	21.363	61	9.438	0.0	22.810	127	8.763	-1.447*
nb_indep_claims	1.0	3.129	67	3.626	1.0	3.057	557	3.972	0.0716
dep_claims_ratio	0.0	5.273	71	4.420	0.0	6.792	288	6.254	-1.515*
words_claim	11.7	73.793	2497	57.219	11.0	68.533	22141	60.957	5.260*
experience	0.0	0.830	1		0.0	0.903	1		-0.073*
pseudo fixed effect	0.0	0.553	1	0.455	0.0	0.578	1	0.385	-0.024*
law firm	0.0	0.710	1	0.097	0.0	0.709	1	0.038	0.001
N	19,119				458,735				
	(4.2%)				(95.8%)				

The column t-test reports the difference between the averages of the two groups and the statistical significance of that difference.

* $p < 0.001$.

Table II: Results

Estimator	LPM (1)	Logit (2)	LPM (3)	Logit (4)	LPM (5)	Logit (6)
foreign	-0.021*	-0.051*	-0.012	-0.029*	0.005	0.007
	(0.004)	(0.005)	(0.004)	(0.006)	(0.007)	(0.008)
strategic	0.080*	0.093*	0.077*	0.096*	0.045*	0.048*
	(0.007)	(0.008)	(0.006)	(0.009)	(0.006)	(0.008)
foreign x strategic	-0.067*	-0.058*	-0.064*	-0.060*	-0.041*	-0.046*
	(0.007)	(0.009)	(0.007)	(0.009)	(0.008)	(0.019)
Control variables:						
log_fam_size			0.048*	0.035*	0.092*	0.113*
			(0.001)	(0.002)	(0.005)	(0.006)
log_tot_ipc			-0.004*	-0.006*	0.003	0.003
			(0.001)	(0.001)	(0.003)	(0.004)
nb_inv			0.025*	0.031*	0.031*	0.043*
			(0.000)	(0.001)	(0.001)	(0.002)
nb_app			0.077*	0.153*	0.106*	0.203*
			(0.003)	(0.006)	(0.005)	(0.011)
RTA			-0.010*	-0.008*	-0.003	-0.006
			(0.001)	(0.001)	(0.004)	(0.005)
priority_lag			-0.002*	-0.003*	-0.007*	-0.009*
			(0.000)	(0.000)	(0.001)	(0.001)
exam_request_lag			-0.001*	-0.002*	-0.004*	-0.005*
			(0.000)	(0.000)	(0.000)	(0.000)
log_Nb_indep_cl			-0.009*	-0.011*	0.029*	0.042*
			(0.001)	(0.001)	(0.003)	(0.004)
log_dep_claims_ratio			-0.001	0.000	0.030*	0.042*
			(0.001)	(0.001)	(0.002)	(0.003)
log_words_claim			0.020*	0.024*	0.084*	0.114*
			(0.001)	(0.002)	(0.004)	(0.006)
experience			0.047*	0.045*	0.052*	0.031*
			(0.002)	(0.002)	(0.006)	(0.006)
Fixed effects:						
pseudo fixed effect	0.568*	0.568*	0.548*	0.546*	0.336*	0.304*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.005)
law firm			0.311*	0.350*	0.223*	0.213*
			(0.015)	(0.018)	(0.027)	(0.030)
app_Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
1-digit IPC Effects	Yes	Yes	Yes	Yes	Yes	Yes
_cons	0.425*		-0.065*		-0.167*	
	(0.005)		(0.014)		(0.032)	
N	477,854	477,854	477,854	477,854	49,463	49,463
R^2	0.245	0.215	0.260	0.230	0.193	0.177

Standard errors in parentheses

* $p < 0.001$

For the logit models the R^2 row reports the pseudo R^2 .

The average marginal effect for the interaction term is computed using the methodology proposed by Ai and Norton (2003).

Table III: Results for standard-essential patents

Estimator	LPM (1)	Logit (2)	LPM (3)	Logit (4)
foreign	-0.018*	-0.048*	-0.009	-0.026*
	(0.004)	(0.005)	(0.004)	(0.006)
strategic (not_SEP)	0.076*	0.088*	0.074*	0.091*
	(0.007)	(0.008)	(0.007)	(0.009)
foreign x strategic (not_SEP)	-0.063*	-0.052*	-0.061*	-0.055*
	(0.007)	(0.001)	(0.007)	(0.001)
SEP	0.228*	0.343*	0.224*	0.350*
	(0.017)	(0.036)	(0.017)	(0.036)
foreign x SEP	-0.130*	-0.091*	-0.140*	-0.106*
	(0.019)	(0.001)	(0.019)	(0.001)
Control variables:				
log_fam_size			0.048*	0.034*
			(0.001)	(0.002)
log_tot_ipc			-0.004*	-0.006*
			(0.001)	(0.001)
nb_inv			0.025*	0.031*
			(0.000)	(0.001)
nb_app			0.077*	0.153*
			(0.003)	(0.006)
RTA			-0.010*	-0.008*
			(0.001)	(0.001)
priority_lag			-0.002*	-0.003*
			(0.000)	(0.000)
exam_request_lag			-0.001*	-0.002*
			(0.000)	(0.000)
log_independent_cl			-0.010*	-0.011*
			(0.001)	(0.001)
log_dep_claims_ratio			-0.001	0.000
			(0.001)	(0.001)
log_words_pc			0.020*	0.024*
			(0.001)	(0.002)
experience			0.047*	0.044*
			(0.002)	(0.002)
Fixed effects:				
pseudo fixed effect	0.568*	0.568*	0.548*	0.546*
	(0.002)	(0.002)	(0.002)	(0.002)
law firm			0.312*	0.351*
			(0.015)	(0.018)
app_Year Effects	Yes	Yes	Yes	Yes
1-digit IPC Effects	Yes	Yes	Yes	Yes
N	477,854	477,854	477,854	477,854
R^2	0.246	0.215	0.260	0.231

Standard errors in parentheses.

* $p < 0.001$.

The average marginal effect for the interaction term is computed using the methodology proposed by Ai and Norton (2003).

Table IV: Sensitivity to hidden bias

	Foreign		Foreign and Strategic	
% bias	Interaction effect	t-stat	Interaction effect	t-stat
1 %	-0.063*	-9.58	-0.062*	-9.34
5 %	-0.063*	-9.54	-0.054*	-8.15
10 %	-0.062*	-9.56	-0.046*	-6.98
15 %	-0.062*	-9.60	-0.039*	-5.83
20 %	-0.062*	-9.59	-0.031*	-4.64
25 %	-0.062*	-9.59	-0.023*	-3.50
30 %	-0.063*	-9.60	-0.016	-2.36
N	477,853		477,853	

* $p < 0.001$.

Table V: Results recovered through different measures of the pseudo fixed effect

pseudo fixed effect	No_Home_Auth	Auth_Severity	No_TW_Auth
foreign	0.008	-0.017*	-0.011
	(0.004)	(0.004)	(0.004)
strategic	0.081*	0.052*	0.080*
	(0.006)	(0.006)	(0.006)
foreign x strategic	-0.066*	-0.042*	-0.067*
	(0.007)	(0.007)	(0.007)
N	447,285	477,853	475,994
R^2	0.251	0.251	0.256

Column No_home_Auth shows results for the PFE computed by discarding the grant outcome at the home patent authority; Column Auth_Severity for the PFE computed as a weighted average taking into account the severity of each office; Column No_TW_Auth for the PFE computed by discarding the grant outcome at the Taiwanese patent authority.
Standard errors in parentheses.
* $p < 0.001$.
Control variables included but not reported.

Table VI: Results recovered by excluding applicants of not certain origin

	(1)	(2)	(3)
foreign	-0.059*	-0.053*	-0.004
	(0.006)	(0.005)	(0.005)
strategic	0.077*	0.075*	0.072*
	(0.007)	(0.007)	(0.007)
foreign x strategic	-0.065*	-0.061*	-0.059*
	(0.007)	(0.007)	(0.007)
N	430,407	473,252	475,218
R^2	0.266	0.262	0.261

Standard errors in parentheses.

* $p < 0.001$.

Control variables included but not reported.

Table VII: Results (USPTO)

	USPTO-All		USPTO-Non U.S.	
	(1)	(2)	(3)	(4)
China	-0.050*	-0.054*	-0.034*	-0.040*
	(0.005)	(0.005)	(0.005)	(0.006)
strategic	-0.059*	-0.069*	-0.063*	-0.078*
	(0.002)	(0.002)	(0.002)	(0.003)
strategic x China	-0.027	-0.032	-0.039*	-0.046*
	(0.008)	(0.009)	(0.009)	(0.001)
Control variables				
log_fam_size	0.057*	0.059*	0.055*	0.060*
	(0.002)	(0.002)	(0.002)	(0.003)
log_tot_IPC	0.027*	0.031*	0.032*	0.039*
	(0.001)	(0.001)	(0.001)	(0.002)
priority_lag	-0.040*	-0.045*	-0.007*	-0.008*
	(0.001)	(0.001)	(0.001)	(0.001)
nb_inv	0.005*	0.005*	0.004*	0.005*
	(0.000)	(0.001)	(0.001)	(0.001)
nb_app	-0.013*	-0.019*	-0.008	-0.012
	(0.003)	(0.004)	(0.004)	(0.004)
experience	0.028*	0.033*	0.050*	0.058*
	(0.003)	(0.003)	(0.003)	(0.004)
RTA	0.001	0.001	0.001	0.002
	(0.001)	(0.001)	(0.001)	(0.001)
log_claims	0.005*	0.008*	-0.007*	-0.008*
	(0.001)	(0.001)	(0.001)	(0.002)
Fixed effects				
Pseudo fixed effect	0.524*	0.535*	0.564*	0.593*
	(0.002)	(0.002)	(0.002)	(0.003)
app_Year effects	Yes	Yes	Yes	Yes
1-digit IPC effects	Yes	Yes	Yes	Yes
_cons	0.174*		0.109*	
	(0.007)		(0.007)	
N	362,439	362,439	292,632	292,632
R^2	0.218	0.184	0.231	0.189

Standard errors in parentheses.

* $p < 0.001$.

Average marginal effect for the interaction term computed using the methodology proposed by Ai and Norton (2003).

For the logit models the R^2 row reports the pseudo R^2.

Table VIII: Descriptive statistics by applicant origin for the matched sample

	Chinese applicants				Foreign applicants				t-test
	min	mean	max	sd	min	mean	max	sd	Diff.
strategic	0.0	0.345	1		0.0	0.338	1		0.006
family_size	2.0	3.017	21	1.659	2.0	3.187	23	1.620	-0.170*
tot_IPC	1.0	2.479	15	1.312	1.0	2.498	16	1.403	-0.0182
nb_inv	0.0	2.436	20	1.861	0.0	2.404	25	1.831	0.0315
nb_app	0.0	1.145	7	0.369	1.0	1.116	9	0.412	0.028*
RTA	0.0	0.662	1		0.0	0.639	1		0.023*
exam_request_lag	3.0	21.364	61	9.438	3.0	21.447	88	9.175	-0.083
nb_indep_claims	1.0	3.137	67	3.658	1.0	3.120	189	4.015	0.017
dep_claims_ratio	0.0	5.273	71	4.420	0.0	5.394	60	4.539	-0.121
words_per_claim	11.7	73.793	2497	57.220	12.0	72.945	2637	48.849	0.848
experience	0.0	0.830	1		0.0	0.820	1		0.010
pseudo fixed effect	0.0	0.553	1	0.455	0.0	0.561	1	0.438	-0.008
law firm	0.0	0.710	1	0.097	0.0	0.710	1	0.050	0.000
App_Year Effects		Y				Y			-
1-digit IPC Effects		Y				Y			-
N	19,118				30,345				

The column t-test reports the difference between the averages of the two groups and the statistical significance of that difference.

* $p < 0.001$