Getting international patents: does the quality of patent attorney matter?

Gaétan de Rassenfosse[*], Paul H. Jensen[#], T'Mir D. Julius[†],
Alfons Palangkaraya[†], Elizabeth Webster[†]

[*]Ecole polytechnique fédérale de Lausanne, Lausanne, Switzerland
[#]The University of Melbourne, Melbourne, Australia
[†]Swinburne University of Technology, Melbourne, Australia

Draft. June 2018

Abstract

Failure to obtain a patent in foreign jurisdictions weakens the global market position and production chain of multinational enterprises whose main source of competitive advantage lies in patentable subject matter domains. For such enterprises, finding ways to optimise the chance to obtain multi-jurisdictional patent protection is a business imperative. Using information from patent applications of over 100 thousand inventions filed in at least two of the five largest patent offices in the world between 2000 and 2006, we confirm that the ability to obtain patent protection depends not only on the quality of the invention but also on the quality of the patent attorney. In some cases, the latter is 'surprisingly' more important than the former. We also find that in at least three patent offices having a high-quality patent attorney reduces any foreign applicant bias and increases the chance in getting patent in less codified technology classes such as software and ICT.

JEL Codes:

Keywords: appropriation; discrimination; global patent system

Acknowledgements: This work was financed by the Australian Research Council [ARC Linkage Grant LP110100266 "The Efficiency of the Global Patent System"] with partners IP Australia and the Institute of Patent and Trademark Attorneys. We wish to thank Russell Thomson, Terry Healy, Tom Spurling, Keith Houghton for comments. Special thanks are due to Antonio Bibiano for assisting us with the collation of the data on patent attorneys.

1. INTRODUCTION

Gaining multi-jurisdictional patent protection is a business imperative for leading multinational enterprises (MNEs) in patent-intensive technology domains. Failure to obtain patents in foreign jurisdictions weakens companies' market position and mutes their *ex ante* incentive to invest in innovation. It is not surprising, therefore, to hear accounts that the ability to obtain international patent protection is becoming increasingly important to MNEs (Fink et al. 2013, Danguy and van Pottelsberghe 2014). While there has been considerable attention focused on the patent examination process in recent years – e.g. considering the impact of applicants and patent examiners – there has been very little interest shown in the role of patent attorneys (Reitzig 2004 and Suzeroglu-Melchiors et al. 2017 are notable exceptions).

Prosecuting a portfolio of international patent applications is neither cheap nor straightforward. Obtaining one national patent is expensive but the cost of obtaining a 'family' of patents can be exorbitant. On top of the costs associated with application, there are potential costs associated with the observed systematic biases foreign firms encounter when applying for a patent (Webster *et al.* 2014). The question then arises: what can companies do to maximise the success rate in developing a robust family of international patents both at home and in the foreign jurisdictions?[1]

In this paper, we estimate the impact of the quality of patent attorney on the outcome of patent application in five leading patent jurisdictions—collectively known as IP5 offices—which receive more than 80 per cent of global patent applications: European Patent Office (EPO), Japanese Patent Office (JPO), Korean IP Office (KIPO), Chinese IP Office (SIPO) and United States Patent and Trademark Office (USPTO). We begin by identifying and extracting more than 1.2 million patent applications filed in at least two of the IP5 offices during the period 2000–2006 from the PATSTAT database. Based on the extracted data which represent the population of all equivalent (i.e., family) patent applications filed, we clean and harmonise the patent attorney names associated with the applications and estimate the quality of each patent attorney as an index of invention quality adjusted grant rates of all patent applications handled by the attorneys. We then investigate how the attorney quality impact varies by

[1] Bearing in mind that a more efficacious attorney may be more expensive and not deliver net value.

patent office, the nationality of the inventor/applicant, and the characteristics of the underlying invention including the quality of the invention and the type of technology.

Our results confirm the importance of the quality of patent attorney even after we control for the invention quality. In fact, we find evidence that the lower the quality of the invention the more important the attorney quality is and, in some cases, the quality of patent attorney to be more important than the quality of the invention. We confirm earlier finding of the presence of a bias against foreign applicants and find evidence that a higher quality patent attorney mitigates such bias. We also find the effect of attorney quality to vary by patent office and the type of technology. For the latter, attorney quality is less important in highly codified technologies such as chemical/pharmaceutical and more important in less codified or newer technologies such as software.

The rest of the paper is organized as follows. In Section 2, we provide some background on the international patent system and the role of patent attorneys. Section 3 outlines the empirical strategy. Section 4 provides a description of the data. Section 5 presents results and provides robustness tests. Section 6 concludes with a discussion of the implications for international patent system.

2. BACKGROUND

Uncertainty in the international patent system

Patents exist to provide incentives for non-rivalrous and (largely) non-excludable 'creations of the mind'. As ideas are not just public goods but *global* public goods, they demand a global solution.[2] Although patent rights are territorial, the intent of patent laws is the same across developed countries—an invention must be new-to-the-world, non-obvious and useful. In recognition of the global public good nature of ideas, international agreements on standards and rights have set down minimum standards for intellectual property (IP) protection by national governments in order to minimise the extent of disharmony across jurisdictions and the implied uncertainties. The agreements, particularly the Agreement on Trade-Related

[2] Common to other quasi-judicial decisions, patent granting is a jurisdiction-by-jurisdiction decision—typically a nation. To date, the international patent system operates as a loose federation of national patent offices that make quasi-independent decisions about the patentability of a specific invention based on its novelty, non-obviousness and usefulness.

Aspects of Intellectual Property Rights (TRIPS), have also incorporated a 'national treatment principle', which states that foreigners should be treated in the same, non-discriminatory manner as locals.[3] The intention of this principle is to minimise international free riding on R&D so that nations pay royalties for the use of knowledge created and developed by residents of other countries.

If patents are 'unjustly' refused such that getting a patent in multiple jurisdictions for an identical invention is highly uncertain, the global incentive to invest in invention and innovation for that business will be muted (Scotchmer 2004). Investors have shouldered the upfront costs of invention and if they only receive fragmentary patent protection across the world, then they must re-coup returns over a narrower set of (patented) markets than would otherwise have been the case.

Business demand three features from the international patent system. First, *predictability* of grant. Grants should be based on clearly articulated objective criteria in order to give business the confidence to invest. Second, *consistency* across offices. A patchwork of grants with heterogeneous claims is expensive and complex to manage and enforce. And third, *low cost*. Single-country patenting can cost over $100,000 and the jurisdiction-specific approach to patenting means that considerable multiple handling of applications and deadweight process costs exist.

In a bid to both reduce these costs and standardize the examination decision across national offices, it has become increasingly common for patent offices to share information on applications. The Patent Cooperation Treaty (PCT), introduced in 1970, provides a multi-office application process (150 offices as of January 2018) with a common international search report. Furthermore, the Global Patent Prosecution Highway, established in 2008, encourages work and information sharing between offices.

Nevertheless, despite these measures and the alignment of patent laws, patent offices still make different decisions about the patentability of a specific invention. We find that only two-thirds of applications that have been submitted to all five IP5 offices in the period from 2000

[3] The first national treatment principle was included in the 1883 Paris Convention for the Protection of Industrial Property. It was re-affirmed with Article 3 of the 1995 Agreement on Trade-related Aspects of Intellectual Property (TRIPS), which is backed by the WTO's powerful dispute resolution procedures.

to 2006 receive the same examination outcome. Differences in outcomes might occur because of different definitions of patentable subject matter (e.g., not all offices agree on whether software and business methods should be patented); or because of variations in procedural matters; *inter alia*. There is evidence that patent offices do make systematic errors in patent examinations based on various measures of the technological importance of an invention (Palangkaraya et al. 2011; de Rassenfosse et al. 2016). Perhaps this is unsurprising given that examiners are making subjective evaluations of factors such as the 'non-obviousness' of inventions.[4]

The importance of patent attorney quality

Helfgott (1993) documents considerable differences in the cost of patent attorney firms—and hence presumably also in the level and the quality of service that they provide. However, we are not aware of any study that evaluates the potential impact of differences in attorney quality on patent examination outcome. Ideally, once standard procedures are followed, the outcome of a patent application should not vary systematically with the quality of the attorney used. Instead, the outcome should only depend on the quality of the underlying invention: it is new-to-the-world, non-obvious and useful.

However it is not straightforward for patent examiners to assess whether or not each of the patentability criteria has been satisfied. This ambiguity creates room for the patent attorney to influence the examiner. Although they receive instructions from their clients, patent attorneys are usually in charge of drafting the patent document and orienting the direction of patent examination (Glazier 2000). In addition, the patent prosecution process is essentially a negotiation between the patent attorney and the patent examiner (Lemley and Sampat 2010). We expect therefore that the 'quality' of the attorney (where quality indicates experience, skill or the power of persuasion) would have considerable influence over the outcome patent application. We hypothesise:

Hypothesis: Higher quality patent attorney increases the grant probability.

[4] Ideally, any study of patent examination outcomes would utilize information on the identity of individual examiners. However, aside from the USPTO, which shares data on patent examiners (e.g., Cockburn et al. 2002), this information is largely out-of-reach for the analyst.

It is plausible that the hypothesised attorney quality impact varies systematically along a number of dimensions such as the patent office, the nationality of the inventor/applicant, and the characteristics of the underlying invention including the quality of the invention and the type of technology.

For example, for the case of obtaining international patents, IP offices demand that a local patent attorney is used as the filing agent. Thus, a foreign applicant most likely need to rely on external patent attorneys. In fact, in our dataset, we find only 3 per cent of applications are handled by in-house attorneys, and close to 100 per cent of patent attorneys are local to the office of applications. External attorneys have a number of disadvantages compared to in-house attorneys. For instance, in-house patent attorneys may have better access to the scientists and engineers making for a more nuanced patent specification. It is also possible that in-house attorneys have an organisational motive to make an additional effort to win over the examiner compare to external patent attorneys. As a result, external attorneys could be less effective in assessing and arguing for the patentability of the inventions obtain the required patent protection (Somaya et al. 2007).

Accordingly, we may expect the effect of attorney quality to vary by nationality of the applicant and whether or not an external attorney is used. For example, In relation to existing evidence which shows systematic bias against foreign applicants, we may expect that such bias can be mitigated by the use of higher quality patent attorney if the underlying cause of the bias relates to the prosecution of the patent application.

The role of attorney quality may also depend on how difficult it is to understand the patent prosecution process in each office in different jurisdiction. For example, prosecuting international patent applications by filing a single application through the PCT route is relatively more simple and perhaps easier than filing patent applications individually to each patent office via the 'Paris route'. The former involves filing the priority patent application at any member office of the PCT and designating an international search authority to perform the preliminary search report on the patentability of the invention. Because this preliminary search report is shared across all the states designated in the PCT application, it reduces the complexity faced by patent attorneys in deciding whether or not to proceed to the national phase. Hence, we may expect that the impact of patent attorney quality to be lower for patent application filed through PCT.

Similarly, attorney quality is likely to be more important for obtaining patent in technology areas which are newer or experiencing rapid progress and not as well understood in terms of the ability to identify the technology boundaries. For example, in technologies such as biotechnology and chemical/pharmaceutical which are relatively more codified, we expect the effect of attorney quality to be relatively lower. On the other hand, we expect obtaining software patents would be more reliant on the quality of patent attorney due to higher difficulty in identifying the technology boundaries.

Finally, as argued in the beginning of this section, we can expect that the effect of attorney quality to depends systematically on invention quality. Intuitively, the stronger the quality of the invention, all else equal, the easier it is to argue for its patentability. Hence, the effect of attorney quality would be lower.

3. EMPIRICAL STRATEGY

Attorney quality

We begin by estimating an index of attorney quality. Our basic intuition is simple: a higher quality attorney is the one with a higher success rate in obtaining patent. To account for the possible endogenous relationship between attorney quality and invention quality, both of which determine grant probability in the same decision, our index of attorney quality needs to be conditioned on invention quality. The main problem is that neither attorney quality nor invention quality is directly observable. For invention quality, earlier studies have used forward citation based measured of granted patents to use as a proxy. However, this approach is not feasible for our analysis since our dependent variable involves both granted and refused patent.[5] For attorney quality, there is simply no measure of patent attorney ranking to use.

Our proposed solution is to use invention-quality adjusted average grant rates exploiting two panel features of our data as discussed below. First, a patent attorney may file more than one patent application of different invention. Second, a single invention may be filed and

[5] Over and above this consideration is the increasing concern that citation inflation has been occurring and they are becoming a noisy measure of quality (Kuhn and Younge 2016).

examined in more than one patent offices. These two features allow us to estimate attorney quality while controlling for invention quality by estimating a panel regression with two fixed effects:

$$GRANT_{ijk} = ATTORNEY_{jk} + INVENTION_i + \varepsilon_{ijk} \qquad i \in S_1 \tag{1}$$

where j indexes each specific patent office examining the patentability of invention i, k indexes the attorney handling the filing[6], $INVENTION_i$ is an unobserved fixed effect representing invention quality that is constant across offices because the invention being examined is identical/equivalent, and $ATTORNEY_{jk}$ is an unobserved fixed effect representing attorney quality that we assume to be constant across invention that uses the same attorney within any given office *j*.

We estimate equation (1) with panel linear regression with two fixed effect. The estimated attorney fixed effects is our index of attorney quality: $ATT\widehat{ORN}EY_{jk}$. It is essentially the invention-quality adjusted average grant rates of each $ATTORNEY_{jk}$

<u>Baseline model</u>

Our baseline model is specified as follows:

$$GRANT_{ijk} = f\left(x'_{ij}\beta_1 + \alpha_1 ATT\widehat{ORN}EY_{jk}\right) + INVENTION_i + \gamma_j + \epsilon_{ijk} \qquad i \in S_2 \tag{2}$$

where the subscripts i, j, k are defined as above. The x_{ij} vectors contain exogenous regressors of interest including $Local_{ij}$ (whether or not the inventor of application i has a country address in the jurisdiction of office *j*), PCT_{ij} (whether or not application i in office *j* is filed through the PCT route), and $EXTERNAL_{ij}$ (whether or not the patent attorney used for application *i* in office *j* is external or not). γ_j is patent office fixed effect.

The notations S_1 and S_2 in equations (1) and (2) are used to indicate that we estimate each of them using two distinct subsamples of our dataset. As constructed, our index of attorney quality ($ATT\widehat{ORN}EY_{jk}$) in equation (2) cannot be estimated using the same sample use to

[6] The addition of subscript *j* is to take into account patent offices' requirement of the used of locally registered patent attorneys. That is, even for the same invention and applicant, each filing in different office may be handled by different patent attorney.

estimate its effect. Thus, we randomly split (evenly) our patent application family into two subsamples along the dimension of i (invention).[7] Denoting S_1 as the first random sample consisting of 50% of patent application family and S_2 as the second random sample of the other half of patent application family, we estimate equation 1 based on $i \in S_1$ and equation 2 based on $i \in S_2$.

We estimate the baseline specification using both linear and logistic panel fixed effect regression. The latter is to account for the binary nature of the dependent variable and the intuitive interpretation that what we are estimating is the underlying probability of grant. However, the panel fixed-effect logistic model can only be estimated via conditional maximum likelihood which means patent families with uniform outcomes across offices would need to be excluded. The linear regression has the benefit of retaining families which receive uniform decisions across offices and we include the estimates for comparison.

A cardinal measure of invention quality

In both equations (1) and (2), we control for invention quality by setting it as the unobserved fixed effect. This approach rules out the investigation of the effects of invention quality on patent examination outcome and how it interacts with attorney quality. Our second method is to first, obtain a cardinal estimate of invention quality and then, regression this estimate on examination outcome. However, we can only analyse the effect of invention quality by estimating the regression of the outcome of patent examination in one office at a time. Our cardinal measure of invention quality should not be influenced by the focal office's decision.

First, we obtained $INVENTION_i$ fixed effect from a linear panel regression specified below using sample of examination decision from all non-focal offices (that is, all $j \neq J$): where capital letter *J* indexes the focal office in the second stage (see equation 4):

$$GRANT_{ijk} = f\left(x'_{ij}\beta_2 + \alpha_2 \widehat{ATTORNEY}_{jk}\right) + INVENTION_i^J + \mu_{ijk} \quad i \in S_2; j \neq J \quad (3)$$

[7] Splitting along the dimension of *i* ensures that we do not split any single family: the whole patent family is either in S_1 or S_2. To ensure the robustness of our approach with respect to the random split of our sample, we repeat the estimation of our regressions (equations 3-4) using 100 different random split samples.

From (3), we obtain $\widehat{INVENTION}_i^J$ which is used to estimate the impact of invention quality on grant outcome in the focal office *J*:

$$GRANT_{iJk} = f\left(x'_{iJ}\beta_3 + \alpha_3 \widehat{ATTORNEY}_{Jk} + \theta_3 \widehat{INVENTION}_i^J\right) + \vartheta_{iJk} \qquad i \in S_2 \quad (4).$$

The coefficient estimate θ_3 is the effect of invention quality on grant outcome in the focal patent office *J*.

4. DATA AND DESCRIPTIVE STATISTICS

Sample construction

The construction of the dataset involved a time consuming and highly complex data extraction and linking from distinct sources. The main data source is the EPO Worldwide Patent Statistical database PATSTAT. It provides information on priority filings and their equivalent(s), inventor/applicant country of residence, technological fields (use of International Patent Classification codes), filing route (PCT/Paris Convention), office of international search report (International Search Authority or ISA),[8] and the language of the application. We use the OECD Harmonized Applicant Names (HAN) database for PATSTAT to improve on the identification of applicants within jurisdictions.

Next, we collect information on the application status in each of the five offices. We use the EPO's INPADOC PRS table for PATSTAT to obtain legal status for China and the EPO. We probed the JPO's public access on-line Industrial Property Digital Library Database to recover the legal status at the JPO. We crawled the KIPO's public access on-line IPR Information Service to recover the legal status of patent application filed in South Korea. We identified the USPTO legal status data from the USPTO Public Pair on-line database.

Attorney information was collected during 2016–2017 from Espacenet; the USPTO Bulk Downloads of Patent Application Information Retrieval (PAIR) Data; the Japanese Platform for Patent Information and the Japan Patent Attorneys Association; the Korean Intellectual Property Rights Information Service online search platform; and the Chinese online patent search tool, Patent Search and Analysis of SIPO and the All-China Patent Attorneys Association

[8] In PATSTAT database, the ISA is identified from the "CITN_GENER_AUTH" field in the CITATION table.

(ACPAA) [9]. The attorney information from the JPO, the KIPO and the SIPO was largely clean – accordingly this information was harmonised using a simple string match. EPO attorney information was collected from Espacenet with additional information extracted from patent applications provided directly by the EPO. USPTO and EPO patent agent firms were identified and harmonised using a bigram match as per the procedure used in Julius and de Rassenfosse (2014).[10]

The original population of applications examined and had one-to-one equivalents[11] in at least two of the IP5 offices for our sample period with priority year 2000–2006 contains 461,961 invention families. About 240,000 have equivalents in two of the five offices, whereas approximately 24,000 families have equivalents in all offices. These families collectively account for 1,264,735 applications. We exclude applications that are pending or have no recorded outcome. Lazaridis and van Pottelsberghe (2007) have argued that applications to the EPO that were withdrawn after an 'X' or 'Y' citation should be regarded as 'quasi-refusals' as they were probably withdrawn in response to the negative feedback from the examiner. In our presented estimating model, we classify these EPO quasi-refusals as refusals.

As expected, these equivalent patents may not have identical patent examination outcome across the IP5 offices. For example, about 17 per cent of families filed and examined only in two offices were refused in both offices, 50 per cent are granted in both offices and 33 per cent are granted in one office and refused in the other. The percentage of families with mixed grant outcome jumps to 59 for 'quintuplet' families. This will affect the estimating sample for our fixed-effect binary logit estimation. The conditional likelihood estimation of the model requires heterogeneity in the grant decision—in other words, the fixed effect fully explains the grant outcome if all the patent applications in the family are either rejected or granted. Of those invention families with an examination outcome (either refused or granted), 41.1 per cent have a mixed outcome.

---

[9] These sources are available at the following URLs: https://worldwide.espacenet.com/, https://www.google.com/googlebooks/uspto-patents-pair.html, https://www.j-platpat.inpit.go.jp, http://www.jpaa.or.jp/, http://eng.kipris.or.kr/, http://www.pss-system.gov.cn/sipopublicsearch/portal/uiIndex.shtml, http://www.acpaa.cn/

[10] http://melbourneinstitute.unimelb.edu.au/downloads/working_paper_series/wp2014n15.pdf

[11] We define equivalent applications as patent applications that protect the same invention in at least one other different jurisdiction where each secondary filing claims a one-to-one priority link with a focal priority filing.

Estimating sample

After randomly splitting the sample of invention families evenly into two groups, each contains 106,453 invention families (for a total of 279,220 patent applications). We use the first group for stage 1 estimation sample to construct the index of attorney quality. We use the second group as the stage 2 estimation sample to analyse the impact of attorney quality. Of the stage-2 sample, 29,028 families (for a total of 80,097 patent applications) have heterogeneous patent examination outcomes across the offices which we use to estimate the panel logit specification in equation (3). Table 1 provides a descriptive summary of the stage 2 sample we use to estimate the panel linear and binary logit specification.

Table 1: Stage 2 estimating sample descriptive summary of invention family

VARIABLES	Linear panel Sample (N = 279,220)		Binary logit panel sample (N = 80,097)	
	Mean	Std. Dev.	Mean	Std. Dev.
Grant (1 if granted; 0 if refused/XY withdrawn)	0.872	0.334	0.594	0.491
EPO (N=42,078 and N=13,240 respectively)	0.819	0.385	0.478	0.500
JPO (N=75,361 and N=22,900 respectively)	0.767	0.423	0.278	0.448
KIPO (N=30,278 and N=8,195 respectively)	0.907	0.291	0.699	0.459
SIPO (N=40,977 and N=10,596 respectively)	0.970	0.170	0.901	0.298
USPTO (N=90,526 and N=25,166 respectively)	0.929	0.257	0.779	0.415
Attorney quality (Index = attorney fixed effect)	-0.072	0.133	-0.083	0.149
Local inventor (1 if has a local inventor; 0 otherwise)	0.359	0.480	0.344	0.475
External (1 if use external attorney; 0 otherwise)[12]	0.978	0.148	0.976	0.152
PCT (1 is use PCT route; 0 other)	0.182	0.385	0.189	0.392
Biotech (1 if biotech patent; 0 other)	0.007	0.082	0.009	0.095
ICT (1 if ICT patent; 0 other)	0.224	0.417	0.250	0.433
Software (1 if software patent; 0 other)	0.058	0.233	0.069	0.253
Electrical (1 if electrical patent; 0 other)	0.218	0.413	0.215	0.411
Instruments (1 if instruments patent; 0 other)	0.167	0.373	0.174	0.379
Chemical/Pharma (1 if chem/pharma; 0 other)	0.058	0.233	0.062	0.241
Process engineering (1 if proc. eng.; 0 other	0.081	0.274	0.081	0.273
Mechanical engineering (1 if mech. eng; 0 other)	0.203	0.402	0.171	0.377

From Table 1, as constructed, the two samples differ most distinctly in terms of the grant outcome since the binary logit sample excludes families with uniform grant or refusal outcome in all patent offices. Overall, 85 per cent of the patent applications in IP5 offices in our sample families were granted. This grant rate varies by each patent office. For example,

[12] To identify whether a patent attorney was in-house or not, we estimated the number of applicants each attorney had represented in our dataset. If an attorney had had only one client, we deemed in an in-house attorney (this was 2.8 per cent of our sample). As such, this approximation will overstate the number of in-house attorneys.

USPTO examined patent applications for 90,526 inventions in the sample with 93 per cent grant rate. Of these 90,526 invention, 25,166 received different outcomes in other patent office. The USPTO grant rate of this subsample is significantly lower at 78 per cent. However, Table 1 also shows that in terms of the main explanatory variables used in the baseline regression, the two samples (linear and logit) are relatively much more similar. For example, the proportion of applications with local inventor is 36 per cent in the full sample and 34 per cent in the subsample.

5. RESULTS

All office estimates

Table 2 presents the coefficient estimates of the linear panel estimation results from the main model specified in equation (2). In the baseline specification, we estimate the impact of attorney quality on the examination outcome (whether the patent application is granted as opposed to refused/quasi-refused). The estimate, which can be directly interpreted as the marginal effects, shows that a one-unit increase in attorney quality is associated with 46.2 percentage point increase in the "probability" of getting a grant and this effect is statistically significant.[13] More intuitively, this effect implies replacing the attorney who is placed on the 10th percentile of attorney quality ranking with an attorney ranked on the 90th percentile, a patent application can increase the grant rate by as much as 13.2 percentage points.

The coefficients of the other three regressors are also statistically significant, with the effect of local inventor of 5.9 percentage point confirming existing evidence of local inventor bias. The use of external agent (holding agent quality) and PCT route also increase grant rate, but at significantly lower magnitudes. We also use patent office fixed effect as control variables. The estimated the fixed effects appear to be consistent to existing evidence and anecdotes about "the relative toughness" of different patent offices. Finally, in Appendix 1 we show, for example, that the baseline estimates presented in Table 2 are robust to the use of 99 other random split of our original data in estimating the attorney quality measure (equation 1).

[13] The panel logit model estimates presented later in the paper would provide a more intuitive "probability" of grant interpretation.

Table 2: Coefficient estimates of linear regression (average marginal effect) of attorney quality on whether or not patent application is granted and the specified interaction.[14]
Dependent variable: Grant = 1 if granted; 0 if refused/withdrawn with EPO XY citation
Estimation: Panel linear regression with invention (family) quality fixed effect

	Baseline	**Interaction with local inventor**	**Interaction with PCT filing**	**Interaction with external status**
Attorney quality	0.462*** (0.007)	0.465*** (0.015)	0.516*** (0.009)	0.445*** (0.023)
90th – 10th percentile	0.132*** (0.002)			
Local inventor indicator	0.059*** (0.001)	0.059*** (0.002)	0.062*** (0.002)	0.059*** (0.002)
PCT filing indicator	0.008*** (0.003)	0.008*** (0.003)	-0.010*** (0.003)	0.008** (0.003)
External attorney	0.014*** (0.005)	0.014** (0.006)	0.015*** (0.004)	0.016*** (0.006)
Attorney quality X Local inventor		-0.006 (0.015)		
Attorney quality X PCT filing			-0.237*** (0.014)	
Attorney quality X External agent				0.019 (0.024)
USPTO (v. EPO)	0.070*** (0.002)	0.070*** (0.003)	0.066*** (0.003)	0.070*** (0.002)
KIPO (v. EPO)	0.034*** (0.003)	0.034*** (0.003)	0.029*** (0.003)	0.034*** (0.003)
JPO (v. EPO)	-0.052*** (0.003)	-0.052*** (0.002)	-0.055*** (0.003)	-0.052*** (0.003)
SIPO (v. EPO)	0.093*** (0.002)	0.093*** (0.003)	0.090*** (0.003)	0.093*** (0.003)
constant	0.843*** (0.006)	0.843*** (0.006)	0.863*** (0.003)	0.841*** (0.006)
Invention quality FE	YES	YES	YES	YES
N	279,220	279,220	279,220	279,220
Rho	0.356	0.356	0.357	0.356
R-sq (overall)	0.073	0.073	0.073	0.073

Note: () = bootstrap standard errors. ***/**/* statistically significant at 1/5/10 per cent respectively.

We then expand the baseline model by incorporating interaction effect between attorney quality and each of the main regressors separately. There does not appear to be any statistically significant interaction between attorney quality and the local inventor indicator

[14] To gain an intuition to the magnitude of the marginal effects, in addition to the average marginal effects we also show in the table the estimated effect of a change in quality of attorney from the level corresponding to the 10th percentile in attorney quality distribution to the one corresponding to the 90th percentile.

or whether or not the attorney is an external attorney. However, we find a curious negative interaction effect between attorney quality and the use of PCT filing which suggests the importance of attorney quality is lower when the application is filed through PCT. One plausible reason for this that the harmonisation in filing across different patent offices afforded by PCT simplifies the complexity faced by patent applicants (and their attorneys who represented them).

Table 3 presents the marginal effects of the panel logit (conditional logit) estimation of equation (2).[15] Despite the significant change in the composition of the estimating sample particularly in terms of the grant outcome, we find consistent positive and statistically significant effect of attorney quality. In fact the magnitude of the effect is more than double than estimated with the full sample where we do not have to drop observations with uniform outcomes across offices. Based on the estimated marginal effects of the panel logit model, replacing a 10th percentile attorney with a 90th percentile one increases grant probability by 30 percentage points. If the exclusion of applications for invention families which represent uniformed outcome means the resulting sample consists of more complex applications, this finding suggests that attorney quality is even more important for such cases where offices are less likely to reach uniform decision.

Table 3 also shows consistent results in terms of the effect of local inventor and patent office fixed effects (patent office over grant rates ranking). However, the effect of PCT route and the use of external attorney are no longer statistically significant if we compare them with the estimates based on the full sample in Table 2. The difference in marginal effect estimates does not appear to be caused by significant differences in the distribution of the regressors between the full sample and the subsample as shown in Table 1.

The other interesting difference between the estimates in Tables 2 and 3 is in terms of the marginal effect of the interaction between attorney quality and whether or not the attorney is an external attorney. The attorney quality effect is 23.5 percentage points (or about 27 per cent higher) if the attorney is an external attorney rather than in house. This suggests that attorney quality is more important when an external is used especially when the application

[15] The coefficient estimates are provided in Appendix Table 2.

is more likely to have different patent examination outcomes across offices. The results with regard to the negative interaction between the use of PCT and attorney quality and the statistically insignificant interaction effect between local inventor indicator and attorney quality hold in both samples.

Table 3: Average marginal effect of attorney quality on whether or not patent application is granted and average change in the marginal effect as the interacted variable changes[16]

Dependent variable: Grant = 1 if granted; 0 if refused/withdrawn with EPO XY citation

Estimation: Panel logistic regression with invention (family) quality fixed effect

	Baseline	**Interaction with local inventor**	**Interaction with PCT filing**	**Interaction with external status**
Attorney quality	0.847*** (0.021)	0.826*** (0.021)	0.870*** (0.022)	0.855*** (0.024)
90^{th} – 10^{th} percentile	0.300*** (0.008)			
Local inventor (v. foreign inventor)	0.115*** (0.003)	0.116*** (0.003)	0.125*** (0.004)	0.116*** (0.008)
PCT filing (v. direct national filing)	0.008 (0.009)	0.008 (0.009)	0.003 (0.009)	0.007 (0.008)
External attorney (v. in-house attorney)	0.011 (0.011)	0.011 (0.012)	0.014) (0.013)	0.021 (0.013)
Attorney quality X Local inventor		0.027 (0.025)		
Attorney quality X PCT filing			-0.434*** (0.040)	
Attorney quality X External agent				0.235*** (0.064)
USPTO (v. EPO)	0.163*** (0.007)	0.167*** (0.006)	0.154*** (0.006)	0.157*** (0.006)
KIPO (v. EPO)	0.079*** (0.010)	0.079*** (0.008)	0.063*** (0.008)	0.075*** (0.010)
JPO (v. EPO)	-0.107*** (0.005)	-0.107*** (0.005)	-0.114*** (0.006)	-0.107*** (0.006)
SIPO (v. EPO)	0.318*** (0.008)	0.322*** (0.009)	0.314*** (0.009)	0.301*** (0.010)
Invention quality FE	YES	YES	YES	YES
N	80,097	80,097	80,097	80,097
Log likelihood	-19732.5	-19718.5	-19628.1	-19710.3

Note: () = bootstrap standard errors. ***/**/* statistically significant at 1/5/10 per cent respectively. The interaction effect estimates were obtained from separate regression of each interacted term.

[16] Note that the main effects shown, unlike the linear estimates in Table 2, are total marginal effect (i.e. includes the marginal effect of the interaction).

The estimates presented in Table 4 allow us to investigate the importance of attorney quality across broadly defined technology classification.[17] There is a slight difference between the full sample which includes applications of invention families which received uniform outcomes and the subsample which excludes such families. Overall, the results seem to indicate that in highly codified technology classes such as Chemical/Pharmaceutical and Biotechnology, attorney quality effect is lower, especially if we only consider the case when patent examination outcomes are less likely to be uniform (that is, the panel logit model). The full sample further indicates that attorney quality effect is stronger for the more areas with harder to define or rapidly moving technology areas such as ICT and software.

Table 4: Average change in attorney quality marginal effect on whether or not patent application is granted for different type of technology of underlying invention (base comparison group is "other")

Dependent variable: Grant = 1 if granted; 0 if refused/withdrawn with EPO XY citation
Estimation: Panel linear (OLS) and logistic regression with invention (family) quality fixed effect

Interaction	Panel linear	Panel logit
Attorney quality X Electrical	0.087*** (0.018)	0.222*** (0.039)
Attorney quality X Instruments	0.053*** (0.016)	0.079** (0.031)
Attorney quality X Chemical/Pharmaceutical	-0.189*** (0.033)	-0.398*** (0.056)
Attorney quality X Process Engineering	-0.158*** (0.021)	-0.231*** (0.048)
Attorney quality X Mechanical Engineering	-0.085*** (0.016)	0.084 (0.046)
Attorney quality X Biotechnology	-0.134* (0.079)	-0.643*** (0.091)
Attorney quality X ICT	0.130*** (0.015)	-0.011 (0.037)
Attorney quality X Software	0.172*** (0.030)	-0.039 (0.047)

Note: () = bootstrap standard errors. ***/**/* statistically significant at 1/5/10 per cent respectively. Interaction effect estimates were obtained from separate regression estimation of each focal interacted technology class. All regressions include the baseline regressors (Attorney quality, Local inventor, PCT filing and External attorney)) For the panel linear model, total number observations used in the estimation is 279,220, representing 106,453 invention family simultaneously examined in the IP5 offices. For the logit model, total number observations used in the estimation is 80,097, representing 29,028 invention family simultaneously examined in the IP5 offices with at least one different outcome.

[17] The estimates shown are the marginal effects of the interaction terms obtained from separate estimation with one interaction term at one time. To save space, from Table 4 and on we omit presenting the coefficient estimates. These are available upon request from the corresponding author.

Separate office estimates

Table 5 presents the marginal effects of logit[18] estimation of equation (4) which allow us to investigate the role of attorney quality from two additional important angles: how the effect varies across offices and how it compares to the effect of the quality of the underlying invention. First, attorney quality is important to obtain grant in every office. The magnitude varies from 1.5 percentage points (if we compare between 10th and 90th percentile attorney) in China's patent office to 10.2 percentage points in the European patent office. This and the findings based on all of the other regressors presented in Table 5 provides an important evidence for significant inter-office heterogeneity in patent examination outcomes and in the relationship between certain parameters that may affect the examination outcomes.

Table 5: Average marginal effect of attorney and invention quality on whether or not patent application is granted
Dependent variable: Grant = 1 if granted; 0 if refused/withdrawn with EPO XY citation
Estimation: Logistic regression

	EPO	**USPTO**	**KIPO**	**JPO**	**SIPO**
Attorney quality	0.363***	0.235***	0.255***	0.358***	0.201***
	(0.014)	(0.009)	(0.027)	(0.012)	(0.025)
90th – 10th percentile	0.102***	0.037***	0.031***	0.093***	0.015***
	(0.004)	(0.001)	(0.004)	(0.002)	(0.002)
Invention quality	0.209***	0.019***	0.142***	0.199***	0.045***
	(0.006)	(0.002)	(0.004)	(0.006)	(0.003)
90th – 10th percentile	0.117***	0.020***	0.083***	0.079***	0.027***
	(0.004)	(0.003)	(0.002)	(0.003)	(0.002)
Local inventor (v. foreign inventor)	0.081***	0.017***	0.056***	0.094***	-0.010
	(0.003)	(0.002)	(0.004)	(0.003)	(0.007)
PCT filing indicator (v. direct national filing)	0.096***	-0.071***	0.083***	0.033***	0.023***
	(0.004)	(0.004)	(0.006)	(0.004)	(0.002)
External attorney (v. in-house attorney)	0.040***	-0.017**	-0.065	-0.004	-0.038***
	(0.009)	(0.008)	(0.046)	(0.008)	(0.013)
N	41,317	89,219	30,010	74,596	40,261
Log likelihood	-17618.2	-21675.2	-8672.2	-39138.4	-5078.5

Note: () = bootstrap standard errors. ***/**/* statistically significant at 1/5/10 per cent respectively. Regression estimates are based on separate regression of each patent office.

[18] This is a cross-section binary logit model estimation of patent examination outcome in each office. Since it is not a conditional logit model, there is no difference between the sample for logit or OLS estimation and hence we only present the logit model estimates.

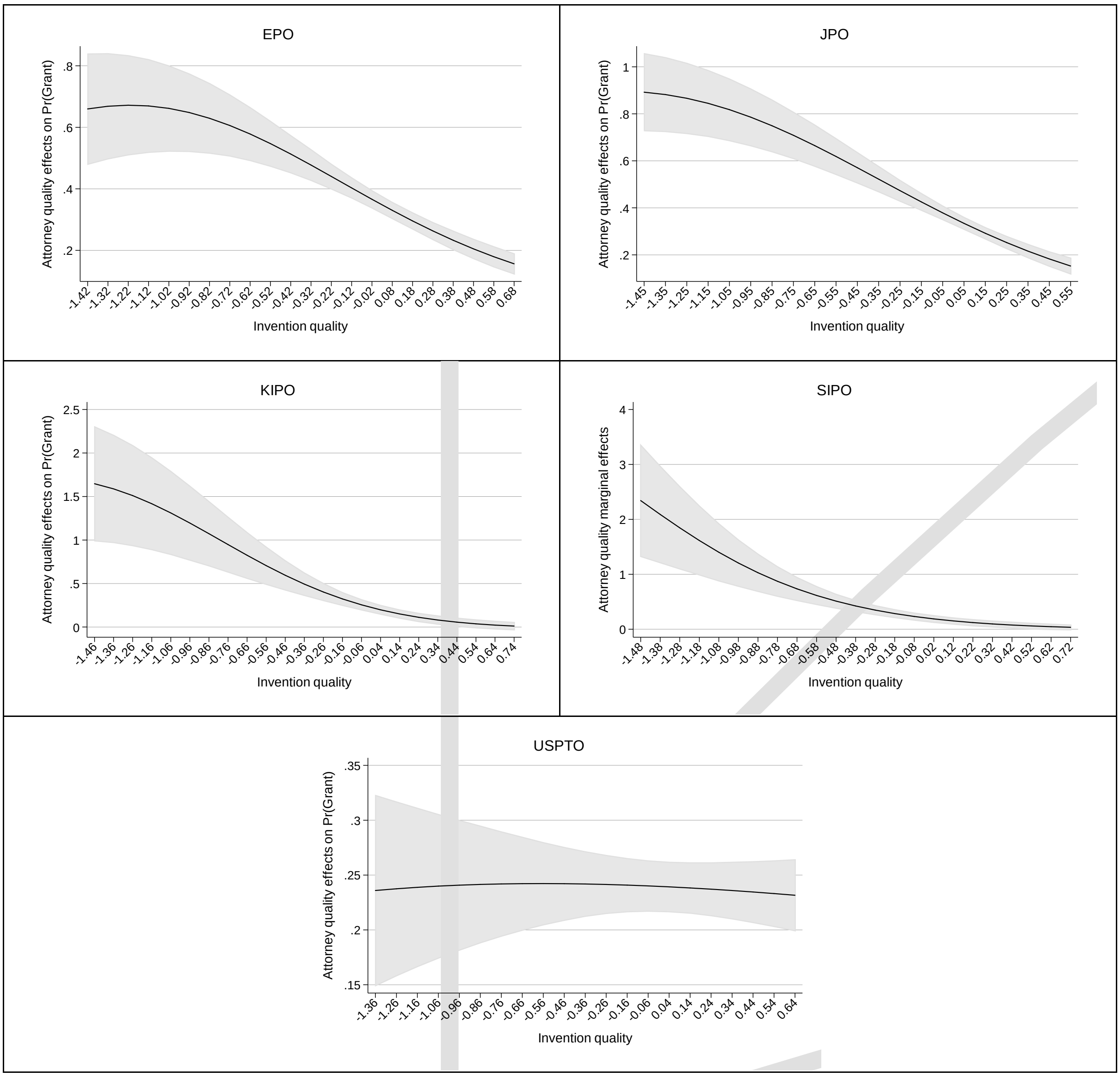
It is difficult to compare the importance of attorney quality to the importance of invention quality in absolute terms given the lack of a common unit of measure. If we compare the effect from increasing both measures from a level corresponding to the 10th percentile in quality rank to the 90th percentile, we find the relative importance between the two quality-measures vary across offices too. For example, at the USPTO the effect of attorney quality on grant probability (3.7 percentage points) is 185 per cent of the effect of invention quality (2 percentage points). In contrast, at KIPO the effect of attorney quality (3.1 percentage points) is only 37 per cent of the effect of invention quality (8.3 percentage points).

Figure 1 shows how attorney quality and invention quality interact based on the average of the marginal effects of the particular interaction term evaluated at each level of invention quality from minimum to maximum. Except for USPTO, the interaction effect is intuitively positive in that the lower the invention quality the more important it is to have a high quality attorney. This is particularly so for applications which underlying invention has below average quality.[19] The case of USPTO is intriguing and worthy for further analysis in the future: a good quality attorney is important regardless of the quality of the underlying invention.

Finally, Tables 6 and 7 present the (marginal) interaction effects between attorney quality and invention quality on one hand and each of the other regressors such as local inventor indicator and type of technology on the other. The first interaction in Table 6 between attorney quality and local inventor is interesting because unlike in the all office estimate presented in Tables 2 and 3 discussed earlier, the effect is statistically significant for all IP5 offices but China. The estimates for KIPO, JPO and USPTO suggest that having a higher quality attorney can mitigate the local inventor bias (or, equivalently, for attorney quality is less important for local inventor). However, the corresponding estimate for EPO suggests the opposite and it is not immediately clear why. In terms of invention quality and local inventor interaction, the estimates suggest a more consistent relationship across offices. Intuitively, the local inventor bias is lower for application with higher quality of the underlying invention.

[19] The average invention quality index value for the sample in each office is -0.007 for EPO, -0.007 for KIPO, 0.008 for JPO, -0.006 for USPTO and 0.015 for SIPO.

Figure 1: Average change in attorney quality marginal effect on probability of grant as invention quality increases



Note: Estimated based on logit model (equation 4) with attorney quality and invention quality interaction term. Shaded area is the 95% confidence intervals. Standard errors are bootstrapped.

Table 6: Average change in the marginal effect of <u>attorney quality</u> on whether or not patent application is granted based on various interaction

Dependent variable: Grant = 1 if granted; 0 if refused/withdrawn with EPO XY citation

Estimation: Logistic regression

Interaction	**EPO**	**USPTO**	**KIPO**	**JPO**	**SIPO**
Local inventor X Attorney quality	0.055** (0.024)	-0.073*** (0.017)	-0.132*** (0.054)	-0.056*** (0.027)	-0.104 (0.090)
PCT filing indicator X Attorney quality	-0.200*** (0.026)	-0.003 (0.029)	-0.197*** (0.044)	-0.167*** (0.039)	-0.005 (0.100)
External attorney X Attorney quality	-0.060 (0.047)	0.079*** (0.023)	0.214** (0.093)	0.081 (0.043)	0.124** (0.057)
Electrical X Attorney quality	0.094** (0.042)	-0.019 (0.023)	-0.060 (0.057)	0.061 (0.033)	-0.100 (0.058)
Instruments X Attorney quality	0.004 (0.036)	-0.060** (0.024)	0.013 (0.062)	0.051 (0.028)	0.205** (0.090)
Chemical/Pharmaceutical X Attorney quality	-0.129*** (0.036)	-0.128*** (0.041)	-0.068 (0.101)	-0.272*** (0.058)	-0.015 (0.093)
Process engineering X Attorney quality	0.050 (0.038)	-0.140*** (0.027)	0.097 (0.074)	-0.214 (0.037)	-0.046 (0.070)
Mechanical engineering X Attorney quality	-0.167*** (0.027)	-0.176*** (0.030)	0.005 (0.065)	0.058 (0.031)	-0.094 (0.049)
Biotechnology X Attorney quality	0.069 (0.141)	-0.244*** (0.068)	0.344 (0.319)	0.006 (0.132)	0.409 (0.899)
ICT X Attorney quality	0.117*** (0.031)	0.264*** (0.024)	-0.046 (0.055)	0.101*** (0.030)	0.171 (0.112)
Software X Attorney quality	0.189*** (0.061)	0.307*** (0.052)	0.193 (0.102)	0.165*** (0.052)	-0.052 (0.191)
N	41,317	89,219	30,010	74,614	40,261

Note: () = bootstrap standard errors. ***/**/* statistically significant at 1/5/10 per cent respectively. Regression estimates are based on separate regression of each patent office and each interaction term. All regressions include the baseline regressors (Attorney quality, Invention quality, Local inventor, PCT filing and External attorney).

Table 7: Average change in the marginal effect of <u>invention quality</u> on whether or not patent application is granted based on various interaction

Dependent variable: Grant = 1 if granted; 0 if refused/withdrawn with EPO XY citation
Estimation: Logistic regression

Interaction	**EPO**	**USPTO**	**KIPO**	**JPO**	**SIPO**
Local inventor X Invention quality	-0.183*** (0.014)	-0.002 (0.006)	-0.154*** (0.010)	-0.240*** (0.013)	-0.003 (0.010)
PCT filing indicator X Invention quality	-0.146*** (0.012)	-0.046*** (0.015)	-0.150*** (0.022)	0.055*** (0.015)	-0.033*** (0.007)
External attorney X Invention quality	-0.034 (0.043)	0.060*** (0.011)	-0.025 (0.106)	0.102*** (0.033)	0.118*** (0.037)
Electrical X Invention quality	0.047** (0.020)	-0.010 (0.005)	-0.018 (0.011)	0.040*** (0.016)	-0.013*** (0.005)
Instruments X Invention quality	-0.012 (0.015)	-0.014** (0.006)	0.017 (0.013)	-0.010 (0.015)	-0.009 (0.006)
Chemical/Pharmaceutical X Invention quality	-0.007 (0.017)	0.016 (0.011)	0.046*** (0.018)	0.078*** (0.021)	0.024** (0.011)
Process engineering X Invention quality	-0.058 (0.019)	-0.002 (0.007)	-0.013 (0.017)	0.028 (0.026)	-0.030*** (0.009)
Mechanical engineering X Invention quality	-0.010 (0.014)	-0.008 (0.005)	0.078*** (0.018)	0.074*** (0.016)	-0.007 (0.006)
Biotechnology X Invention quality	0.064 (0.040)	-0.003 (0.032)	-0.057 (0.070)	-0.056 (0.049)	0.091*** (0.041)
ICT X Invention quality	0.031** (0.015)	0.022*** (0.006)	-0.026** (0.010)	-0.096*** (0.013)	0.025*** (0.007)
Software X Invention quality	0.025 (0.025)	0.016 (0.012)	-0.015 (0.017)	-0.118*** (0.017)	0.009 (0.010)
N	41,317	89,219	30,010	74,614	40,261

Note: () = bootstrap standard errors. ***/**/* statistically significant at 1/5/10 per cent respectively. Regression estimates are based on separate regression of each patent office and each interaction term. (Attorney quality, Invention quality, Local inventor, PCT filing and External attorney)

6. CONCLUSION

Competitive advantage arises traditionally from the firm internal resources. To the extent international patent protection forms part of the competitive advantage for multi-national enterprises, we find that the quality of the patent attorney matters.

We confirm the existence of domestic inventor bias, as found in previous studies, which suggests that the national treatment principle is still not being upheld. In this study, however, we push the analysis further to uncover factors that may be working for or against applicants.

We find that a patent attorney firm from the top decile can raise the probability of a grant by at least 13.2 to 30.0 percentage points compared with an attorney firm in the bottom decile. This effect is even greater if the application follows the Paris Convention or is in the technology classes of electrical, instruments, ICT or software.

We have also found that the effect of attorney quality is larger than the effect of invention quality in the USPTO and the JPO and its absolute impact is greatest in the EPO and JPO. Furthermore, attorney quality matters more when the invention is of lower quality. In the USPTO, KIPO and JPO having a high-quality patent attorney reduces the foreign applicant bias.

Multi-national enterprises and scholars should not assume that worthwhile inventions will be granted a patent in foreign jurisdictions, even if they have been granted 'at home'. Previous literature has shown the presence of randomness in the examination process (through the allocation of patent examiners with different stringency levels). We confirm the presence of randomness but also show that the choice of patent attorney firm has a strong effect on the probability of grant. Ideally we would observe no effect (patent laws stipulate that a patent application should be assessed on the technical merit of the invention, not on the arguments of the patent attorney), the reality is that the patent application process is complex to navigate and the ability of attorneys matters in terms of the examination outcome. We leave the question of why for future research.

APPENDIX

Appendix Table 1: Summary statistics of baseline model (equation 2) coefficient estimates from linear panel estimations of 100 sets of random samples

	Obs.	**Mean**	**Std. Dev.**	**Min**	**Max**
Attorney quality	100	0.461	0.009	0.439	0.481
Local inventor	100	0.058	0.002	0.053	0.061
PCT	100	0.009	0.002	0.003	0.014
External	100	0.012	0.005	-0.001	0.025

Appendix Table 2: Coefficient estimates of the panel logit model of the effect of attorney quality and its interactions on the probability of grant

Dependent variable: Grant = 1 if granted; 0 if refused/withdrawn with EPO XY citation

Estimation: Panel logistic regression with invention (family) quality fixed effect

	Baseline	**Interaction with local inventor**	**Interaction with PCT filing**	**Interaction with external status**
Attorney quality	4.335*** (0.092)	4.069*** (0.125)	4.962*** (0.125)	3.039*** (0.333)
Local inventor (v. foreign inventor)	0.607*** (0.021)	0.662*** (0.025)	0.641*** (0.021)	0.604*** (0.022)
PCT filing (v. direct national filing)	0.040 (0.039)	0.041 (0.033)	-0.195*** (0.045)	0.037 (0.036)
External attorney (v. in-house attorney)	0.057 (0.064)	0.056 (0.069)	0.071 (0.069)	0.234*** (0.075)
Attorney quality X Local inventor		0.508*** (0.181)		
Attorney quality X PCT filing			-2.511*** (0.187)	
Attorney quality X External agent				1.445*** (0.354)
USPTO (v. EPO)	0.729*** (0.027)	0.748*** (0.025)	0.686*** (0.029)	0.718*** (0.026)
KIPO (v. EPO)	0.344*** (0.035)	0.346*** (0.037)	0.275*** (0.033)	0.333*** (0.033)
JPO (v. EPO)	-0.479*** (0.024)	-0.475*** (0.022)	-0.515*** (0.025)	-0.471*** (0.024)
SIPO (v. EPO)	1.580*** (0.043)	1.617*** (0.045)	1.545*** (0.009)	1.561*** (0.010)
Invention quality FE	YES	YES	YES	YES
N	80,097	80,097	80,097	80,097
Log likelihood	-19732.5	-19718.5	-19628.1	-19710.3

Note: () = bootstrap standard errors. ***/**/* statistically significant at 1/5/10 per cent respectively. The interaction effect estimates were obtained from separate regression of each interacted tern,

REFERENCES

Cockburn, I.M., Kortum, S and Stern, S. (2002). "Are all Patent Examiners Equal? The Impact of Examiner Characteristics". *NBER Working Paper 8980*.

Danguy, J. and van Pottelsberghe de la Potterie, B. (2014). "The policy dilemma of the unitary patent". Bruegel Working Paper, No. 2014/13.

de Rassenfosse, G., Dernis, H., Guellec, D., Picci, L., and van Pottelsberghe de la Potterie, B. (2013). "The worldwide count of priority patents: A new indicator of inventive activity". *Research Policy* 42(3), 720–737.

de Rassenfosse, G., Jaffe, A. B., and Webster, E. (2016). "Low-quality patents in the eye of the beholder: Evidence from multiple examiners". *NBER Working Paper 22244*.

Fink, C., Khan, M. and Zhou, H. (2013). "Exploring the worldwide Patent surge". World Intellectual Property Office Economic Research Working Paper No. 12. September 2013.

Glazier, S. (2010). *Patent Strategies for Business*, 3rd Edition. LBI Law & Business Institute, Washington, D.C., 420p.

Hausman JA. (1978) "Specification Tests in Econometrics". *Econometrica*. 46:1251–1271.

Helfgott, S. (1993). "Patent filing costs around the world". *Journal of the Patent & Trademark Office Society*, *75*, 567.

Julius, T. and de Rassenfosse, G. (2014). "Harmonising and Matching IPR Holders at IP Australia", Melbourne Institute Working Paper 15/14.

Lemley, M., and Sampat, B. (2010). "Examining Patent Examination". *Stanford Technology Law Review* 2

Lybbert, T. J., and Zolas, N. J. (2014). "Getting patents and economic data to speak to each other: An 'Algorithmic Links with Probabilities' approach for joint analyses of patenting and economic activity". *Research Policy* 43(3), 530–542

Maskus, K. (2000). “Lessons from studying the international economics of intellectual property rights”. *Vanderbilt Law Review* 53(6) 2219–2239.

Maskus, K.E. and Penubarti, M. (1995). “How Trade-Related Are Intellectual Property Rights?” *Journal of International Economics* 39, 227-48.

Palangkaraya, A., Jensen, P.H. and Webster, E. (2017). “The effect of patents on trade”, *Journal of International Economics* 105, 1-9.

Palangkaraya, A., Webster, E. and Jensen, P.H. (2011). “Misclassification between patent offices: Evidence from a matched sample of patent applications”, *Review of Economics and Statistics* 93(3), 1063–75.

Reitzig, M. (2004). “Improving patent valuations for management purposes—validating new indicators by analyzing application rationales”. *Research Policy* 33 (6–7), 939-57.

Scotchmer, S. (2004). “The political economy of intellectual property treaties”. *Journal of Law, Economics, and Organization* 20(2) 415–437.

Smith, P.J. (1999). "Are weak patent rights a barrier to U.S. exports?" *Journal of International Economics* 48(1), 151-77.

Somaya, D., Williamson, I. O., & Zhang, X. (2007). “Combining patent law expertise with R&D for patenting performance”. *Organization Science*, *18*(6), 922-937.

Süzeroglu-Melchiors, S., Gassmann, O. and Palmie, M. (2017). “Friend or foe? The effects of patent attorney use on filing strategy vis-a-vis the effects of firm experience”. *Management Decision*, 55(6) 1122-42.

Terza, J. V., Basu, A., & Rathouz, P. J. (2008). Two-Stage Residual Inclusion Estimation: Addressing Endogeneity in Health Econometric Modeling. *Journal of Health Economics*, 27(3), 531–543. http://doi.org/10.1016/j.jhealeco.2007.09.009

United States International Trade Commission (2010). “China: Intellectual property infringement, indigenous innovation policies, and frameworks for measuring the effects on the US economy”. *USITC Publication 4199*, Washington, D.C

Webster, E., Jensen, P.H. and Palangkaraya, A. (2014). “Patent examination outcomes and the national treatment principle”. *The RAND Journal of Economics*, *45*(2), 449–469.